This draft report contains detailed historical data related to program activities in the Department's four mission areas as recorded in FY 2000. It is a useful resource document that was intended to characterize Departmental activities and to be made available to support the transition to a new administration. The document was approved by the Laboratory Operations Board (LOB) in July 2001. It is not intended to present the views of any individual member of the LOB and was not presented to the Secretary of Energy Advisory Board for review. The report is not a Department of Energy or Administration document and will not be transmitted officially to the Secretary of Energy.

Laboratory Profile Report

Laboratory-by-Laboratory Profiles
Mission Analysis

FINAL DRAFT
July 2001

Laboratory Operations Board
U.S. Department of Energy
1000 Independence Avenue, SW
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CONTENTS

INTRODUCTION

In 1997, the U.S. Department of Energy (DOE) organized its strategic goals according to four business lines: Energy Resources, Environmental Quality, National Security, and Science. These business lines comprise the four major mission foci, through which all the Department's activities are directed. They provide a comprehensive, integrated context within which the programs and offices manage and execute their mission responsibilities.

As part of its effort to achieve its strategic goals, the Department manages one of the largest and most distinguished laboratory systems in the world. With origins in the Manhattan Project, the laboratories have evolved to become a major component of the Nation's and the Department's infrastructure for maintaining U.S. leadership in the discovery of knowledge and the expansion of technology that helps to insure national and economic security and environmental integrity.

The *Laboratory Profile Report* is intended to provide an overview of the Department's 17 multi-program and program-dedicated laboratories that perform the majority of the research funded by the Department. It attempts to track the linkage from the Department's strategic missions and goals through the program offices to the research and development (R&D) activities performed in the laboratories that support the Department.

The *Laboratory Profile Report* is a follow-on document to the *Strategic Laboratory Mission Plan*, developed and published in 1996. The *Plan* was developed by the Laboratory Operations Board to initiate an analysis of the Department's missions and R&D activities. It was devised as a tool for identifying redundancies in research capabilities at the laboratories and to identify research gaps or areas in which additional tools and capabilities were needed. It was conceived as a planning tool to assist the Department in its effort to streamline the management of the laboratories. This update, the *Laboratory Profile Report,* is a continuation of that effort. Like its predecessor, it has two sections: the **Mission Analysis** section and the **Laboratory by Laboratory Profiles** section.

The **Laboratory by Laboratory Profiles** section is a reference document describing the Department's major research and development (R&D) performers, the DOE national laboratories. The tools and competencies residing at the laboratories and described in the profiles were developed and are maintained as the tools available to address the Department's strategic mission goals through performance of the R&D activities funded by the DOE. As indicated in the profiles, the laboratories work in collaboration with universities and industry as the nature of the task dictates.

The R&D Portfolio approach for managing its R&D investments is set within the context of the Department Of Energy's *Strategic Plan* and is designed to show how the R&D investments support the goals of each of the four business lines. There is an R&D portfolio for each business line. Each portfolio integrates the capabilities, policies and require-

ments of all related programs of the Department and its national laboratories. A process is now in place to perform an annual *R&D Portfolio analysis and update.*

The **Mission Analysis** is a bridging document, linking the strategic mission goals identified in the *Department of Energy Strategic Plan* and the *R&D Portfolios* to the laboratory performers who have the capabilities and competencies to enable the Department to achieve its goals. The Mission Analysis section provides thumbnail sketches of the Department's R&D activities organized by strategic mission area—Energy Resources, Environmental Quality, National Security, and Science. It lists the general goals and objectives of each mission area as they are described by the Department's Principal Secretarial Offices and the R&D activities noted in the *R&D Portfolios*. The laboratory performers for each R&D activity are identified in the Mission Analysis sheet so that anyone needing information about a particular laboratory can go to the Profiles for additional information about the performing laboratory. The linkages between the *R&D Portfolios* and the two sections of the *Laboratory Profile Report* are illustrated in Figure 1.

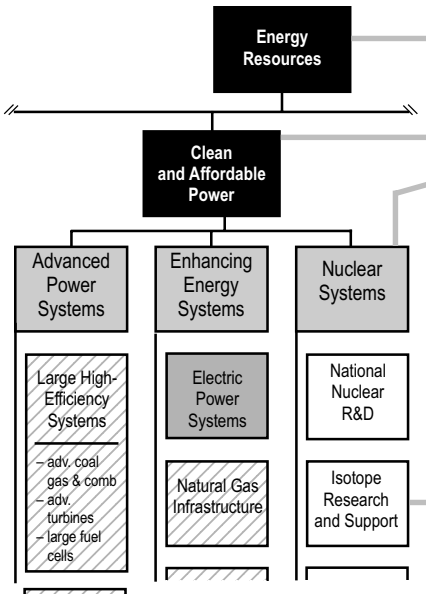
A small portion of the Energy Resources Portfolio is represented on the left in Figure 1. The box entries are the major headings and subheadings in the Mission Analysis. The Mission Analysis section replicates the *R&D Portfolio"* boxology" in the introduction to each mission area. The business lines, i.e., mission areas, from the Portfolios provide a context within which the funded programs and offices manage and execute their funding. The activities identified in the Portfolios depict a complete compilation of the Department's R&D investments aligned according to the hierarchy of strategic goals and objectives. Each R&D Activity listed in the Portfolio by business line, except those funded by the Office of Energy Efficiency and Renewable Energy, is presented in a separate sheet in the Mission Analysis section[1] . The documents together show an integrated system of R&D requirements, activities and performers, all driven by and focused upon achievement of the Department's goals and strategic objectives.

It should be noted that, because the *R&D Portfolio* is a developmental planning document while the *Laboratory Profile Report* is historical in nature, the correspondence between the two documents is not exact. The *Portfolios* are evolving because of the analysis of the mission area business lines that have ensued following its initial publication in February 2000. Other changes in the Department, most importantly the creation of the National Nuclear Security Administration, have resulted in reorganizations that are reflected in the boxology presented in the *Laboratory Profile Report*. In addition, the *Portfolios* were based on the FY 2000 budget authority while the *Laboratory Profile Report* shows actual budget dollars as determined at the end of FY 2000.

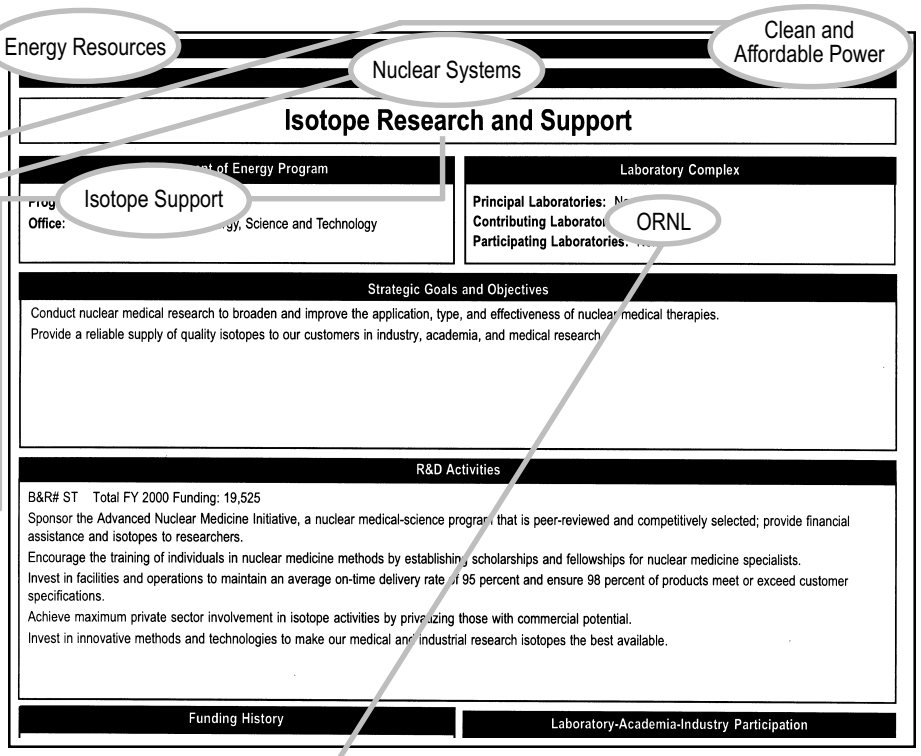
Laboratory by Laboratory Profiles

Each of the Department of Energy's (DOE) laboratories has a distinctive set of capabilities and resources that are used to advance the Department's mission objectives. This section provides concise profiles for each of the Department's 17 laboratories (9 multi-

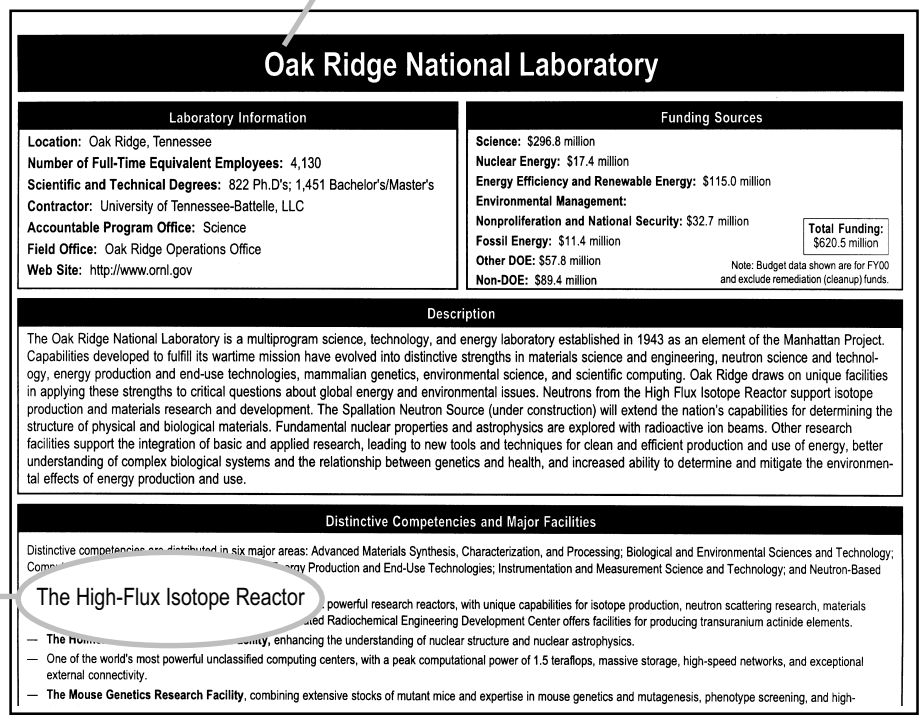
[1] The Energy Efficiency and Renewable Energy Program Area did not provide input to the Mission Analysis; therefore, no information concerning the R&D activities funded by that office are described in this document.



(C) *R&D Portfolio* diagram



(A) Mission Analysis sheet



(B) Laboratory-by-Laboratory Profile sheet

Figure 1. This example illustrates the linkage between the Mission Analysis and the Laboratory-by-Laboratory Profile sections of the *Laboratory Profile Report* and the *Research and Development Portfolio*. The Mission Analysis sheet (A) for the R&D activity titled "Isotope Research and Support" traces directly back to the *R&D Portfolio* diagram (C) showing the breakout of Energy Resources programs for the "Clean and Affordable Power" strategic goal. Additional Information about the laboratory performers can be obtained from the appropriate laboratory profile, as shown in the sample entry for Oak Ridge National Laboratory (B).

program and 8 single-purpose laboratories). Excluded from this report are the two DOE laboratories that support work related to the Naval Reactor programs.

To obtain a true picture of the value and broad expertise of the DOE laboratories, there is no substitute to visiting these institutions and witnessing the research and development (R&D) currently under way across the spectrum of the Department's missions. However, the profiles provide a summary depiction of the major facilities, key research and devel-

opment activities, funding history, relationship to the Department's missions, and key collaborations with other R&D performers for each of the Department's laboratories. More detailed information on each of these laboratories, and on the major facilities and programs supported therein are contained in the Institutional Plans for each laboratory, which are available from the Department or from the laboratory itself. More detailed information about all R&D within a mission area is provided in the Mission Analysis section. As conceived, the Laboratory by Laboratory Profiles and Mission Analyses were to cross-reference the ***R&D Portfolios,*** where the reader should be able to obtain additional information concerning the Department's total R&D effort by mission area.

Several elements in the profiles require explanation.

The budget data listed in the **Funding Sources Box** is the total budget received by the laboratory, including work sponsored by other organizations, "Work-for-Others" (WFA). It does not include transfer funds, i.e., funds transferred from other DOE laboratories. In addition, the budget figure provided does not include remediation funds, i.e., funds for environmental cleanup work that represents a legacy from the past, unless the funds are expended on R&D related to environmental remediation. The DOE Operations Offices provided the budget data for the Profiles to the Office of the Chief Financial Officer, where the data was reviewed prior to inclusion in this report. In most cases, the data represent actual FY 2000 dollars.

The charts at the bottom of the first page of each profile show how the laboratory's funds are used.

The amount reflected in the **Funding by Activity Box** again presents the total budget for each laboratory, excluding remediation. This chart provides a funding history for the laboratory and breaks out the total funding in terms of the major types of expenditures required to support the R&D activities at the laboratories. Capital includes all funds for purchase of equipment and physical plant improvements. Construction includes funds only for line item construction projects. If the construction was clearly unrelated to an R&D facility, then the funds are included in the R&D and Operations category.

The **Funding by Mission Area Box** includes two charts. The first chart, the **DOE R&D Footprint** provides an estimate of funds that are focused only on the support of R&D. The estimate was derived by excluding the "other construction" funds and other funds used to support general-purpose operations, facilities support, and equipment.

The **DOE Mission Footprint** is intended to show how the total funds are allocated by mission area at the laboratory. As will be observed, some laboratories maintain that all expenditures of DOE funds directly support operations necessary to the conduct of R&D and do not attempt to provide an R&D Footprint estimate that is distinguishable from the Mission Footprint.

Since 1995, the laboratories have worked with the Laboratory Operations Board to develop financial performance metrics that could be used to depict savings and cost efficiencies over time. At first, the efforts focused on three financial productivity metrics

to highlight savings brought about through various management reform efforts and which provide a composite picture of financial productivity at a given laboratory.

The metrics demonstrated that the DOE laboratories' research to support cost ratios and total costs per research full-time equivalent were consistent with similar data for private sector research laboratories. The metrics also demonstrated productivity improvements at the laboratories of five percent per year between 1994 and 1997. The improvements resulted from the Department's efforts to adopt and adhere to a more business-like, results-oriented management approach to its laboratories. However, recent developments may be reversing these trends as the Department has complied with congressionally mandated actions related to environmental, safety and health, and security requirements.

- The **Research to Support Ratio** is a ratio of research labor as a factor of support labor. It is intended to show the amount of labor directly associated with research work in the laboratory compared to the amount of support labor not directly associated with research. All operating and capital projects, as well as full time equivalent contract labor, are included.

- The **Percent Technical Labor on Research** highlights the amount of technical effort being expended on research. It expresses the percentage of research labor dollars performed by technical staff. The labor associated with capital projects and major systems acquisitions, such as a new accelerator, are included. However, if a laboratory believes that the labor associated with these projects results in a major distortion of the metric over time it may be excluded.

- The **Average Operating Cost per Research Full Time Equivalent (FTE)** is intended to reflect the cost of managing the laboratory in terms of its operating cost relative to all research FTEs. In order to examine the Average Operating Cost over time, the estimate is adjusted and reported in 1994 dollars. The laboratories use an average inflation adjustment rate of 3.1 percent annually in this calculation. This rate was suggested by the Office of Management and Budget at the time the metrics were being developed.

The **Cost Multipliers** were initiated because there is interest in identifying cost measures that can be used to compare the cost performance of the DOE laboratories with non-DOE R&D laboratories. The multiplier calculation is based on cost charged to operating programs. The multipliers to the direct cost to labor calculated and reported by the laboratories are the Salary-based Labor Multiplier, Third Party Cost Multiplier (procurement, subcontracts, etc.), and Other Direct Cost Multiplier (travel and internal use-rated services).

Each laboratory has a unique management and accounting system that impacts how direct and or indirect costs are charged. Therefore, while these metrics are of interest in reviewing the profiles, comparisons between laboratories may be misleading. However, the effort to identify useful metrics to provide some indications of cost

performance can lead to a reduction in uncertainty with reference to questions concerning the level of support appropriate for these R&D institutions. The purpose of developing and reporting the metrics, which has been ongoing since 1994, is to provide some reassurance that the issue has been and is being addressed by DOE. The Laboratory Operations Board plans to continue working with the laboratories on this effort.

Mission Analysis

The Mission Analysis, compiled from input provided by the Principal Secretarial Offices (PSOs), is structured to follow the *Research and Development (R&D) Portfolio*. The mission analyses focus on the second-, third-, and fourth-level "boxology," from the *R&D Portfolio* white papers and show how each laboratory's work connects to those boxologies through the R&D activities that address the various program areas. The Naval Reactors program chose not to provide data for this report.

The mapping from the R&D Portfolio to the Mission Analyses is as follows: The **Mission Area** is identified at the top left hand side of the Mission Analysis sheet (see Figure 1). The **Strategic Goal** is identified on the top right hand side of the Mission Analysis sheet (this is the second level heading from the portfolio "boxology" chart for the Mission Area in question). A **Program Area** is listed in the center of the next line, followed immediately by the **Research and Development Activity** or **Activity.** For each strategic goal there may be one or more program areas and for each program area there may be any number of research and development activities. Next, the Secretarial **Program Office** and office within the PSO are identified. The **Performers** are those laboratories that are performing work on the R&D activity, identified by the level of involvement of the laboratory. **Principal laboratories** are defined as those receiving more than 20 percent of the activity's funding to the laboratory complex. **Contributing laboratories** are those that receive between 10 and 20 percent of the funding. **Participating laboratories** are labs that contribute to the activity and receive between 0 and 10 percent of the funding. This information relates only to information *with regard to the laboratories. Industry and academic performers are not identified; however, the level of involvement is broken out in the pie chart at the bottom of the page.*

The next two boxes list the goals and objectives and laboratory research activities identified as necessary or desirable for the completing the R&D activity.

Attempts were made to provide **funding history** data for each R&D activity. However, there is no direct mapping of budget data to the portfolio structure, which represents activities that cut across budget categories. In addition, some program offices have new budget and reporting (B&R) codes and have not yet developed a crosswalk from the old to the new codes. Therefore, the funding history data must be viewed as best guess estimates. The PSOs used several different strategies to provide the requested information.

Performer Participation is provided as the percentage of participation of each partner in the enterprise, including industry, DOE laboratories, academia, or other agencies as appropriate.

Fiscal Year 2000 Funding Profile by Program Office shows the funding provided to each laboratory for work on the subject R&D activity by the Program Office.

The mission analysis is intended to be used as a quick reference and can be cross-referenced to the *R&D Portfolios* and the Laboratory by Laboratory Profiles. If more information is desired concerning the activities in which a specific laboratory is engaged, the user may want to go to the Laboratory Profile. If more information is desired concerning an R&D Activity, the *R&D Portfolios* are a useful resource.

Differences in Funding Totals

A careful review will reveal differences between totals reported from the laboratories/ field offices and totals reported by the program secretarial offices. It was expected that the totals provided by source by the laboratories should closely correlate with the totals provided by the program offices. In most cases this expectation was met.

The instructions to the program secretarial offices requested that they provide funding data for the laboratories for the research and development activities described in the *R&D Portfolios*. The program offices were instructed to include non-research technical activities, such as site characterization at Yucca Mountain. This request was intended to focus on activities being undertaken at the laboratories, but to describe all of the activities in which the laboratories were engaged and the funding that supported those activities.

Although the totals reported by the field offices and checked by the office of the Chief Financial Officer correlate well with those submitted by the program offices, some differences exist. In those cases, the laboratories and program offices were asked to explain the differences. Responses are provided below:

Each secretarial program office and laboratory defines the term “research and development” differently, depending on the character of their business line. The DOE laboratories are engaged in work that extends from basic exploratory research to finding technical and applied engineering solutions on a wide range of subject areas. Furthermore, in characterizing R&D funding, some laboratories maintain that the laboratory’s every effort is directed to the support of research and development, whether it is building and maintaining a road to enable the researcher to access his laboratory or it is the purchase of laboratory equipment. Several program offices reported totals from their research or science and technology office, which may not reflect all of the money going to the labs from the program secretarial office.

Defense Programs provided totals for R&D that include the entire budget of the Office of Research, Development, and Simulation (DP-10). This is done as an indication of the fully-loaded costs of the mission-directed R&D activities at the laboratories necessary to support the nuclear weapons program and to avoid confusion regarding the reporting or the nature of the work. In their data submission, the activities itemized for construction, storage, operation of facilities, material and program readiness, and so on were not distributed by laboratory. Also, a portion of that money was actually distributed to production facilities. Because the laboratories reported the total funds received from the

program secretarial offices, their portion of those funds was reported. Therefore, the totals should not be compared.

1. With the creation of the National Nuclear Security Administration (NNSA) during the 2000 fiscal year, the budgeting and reporting (B&R) codes for their R&D activities were changed. At the time of this report preparation, no crosswalk from the old to the new system had been completed. This added to the difficulties the Defense Programs office had in reporting their funding totals.

2. The B&R codes are a product of the budget office. The R&D Portfolios report activities by business line. In many cases the B&R codes included more than one activity, or an R&D activity included portions of funds from several B&R codes. The numbers provided by the program offices in those cases were sometimes best estimates.

3. Some differences may be explained by the fact that money received by a laboratory was transferred from a field office and were reported under the "Other DOE" category. For example, the Chicago Field Office reported $5.6 million in the "Other DOE" category for the Argonne National Laboratory. The Nuclear Energy program office indicated that this sum was money from their program office that had been transferred by the Oakland Field Office to the Argonne Laboratory. The instructions sent to the field offices requested that the total laboratory funding be identified by source. Money transferred from another laboratory was to be credited to the initial recipient. Tracking "lab transfers" is difficult and visibility is sometimes lost.

4. In most cases, the DOE field offices handle procurements. However, the National Energy Technology Laboratory (NETL), a government-owned, government-operated laboratory, as such is both a laboratory and a field office. NETL handles cost-shared research for the Fossil Energy program office, as well as performs in-house research. Cost-shared research money is included in some totals.

5. The Nuclear Energy program office provides direct funding of research and development to the Oak Ridge National Laboratory. The program secretarial office also operates a revolving fund related to the sale of isotopes that helps to support the laboratory's Isotope Development and Production program. The program office reported only the$10.1 million in direct funding appropriated for Oak Ridge National Laboratory. The laboratory reported their total funding ($17.4 million), which included the funds from the Isotope sales.

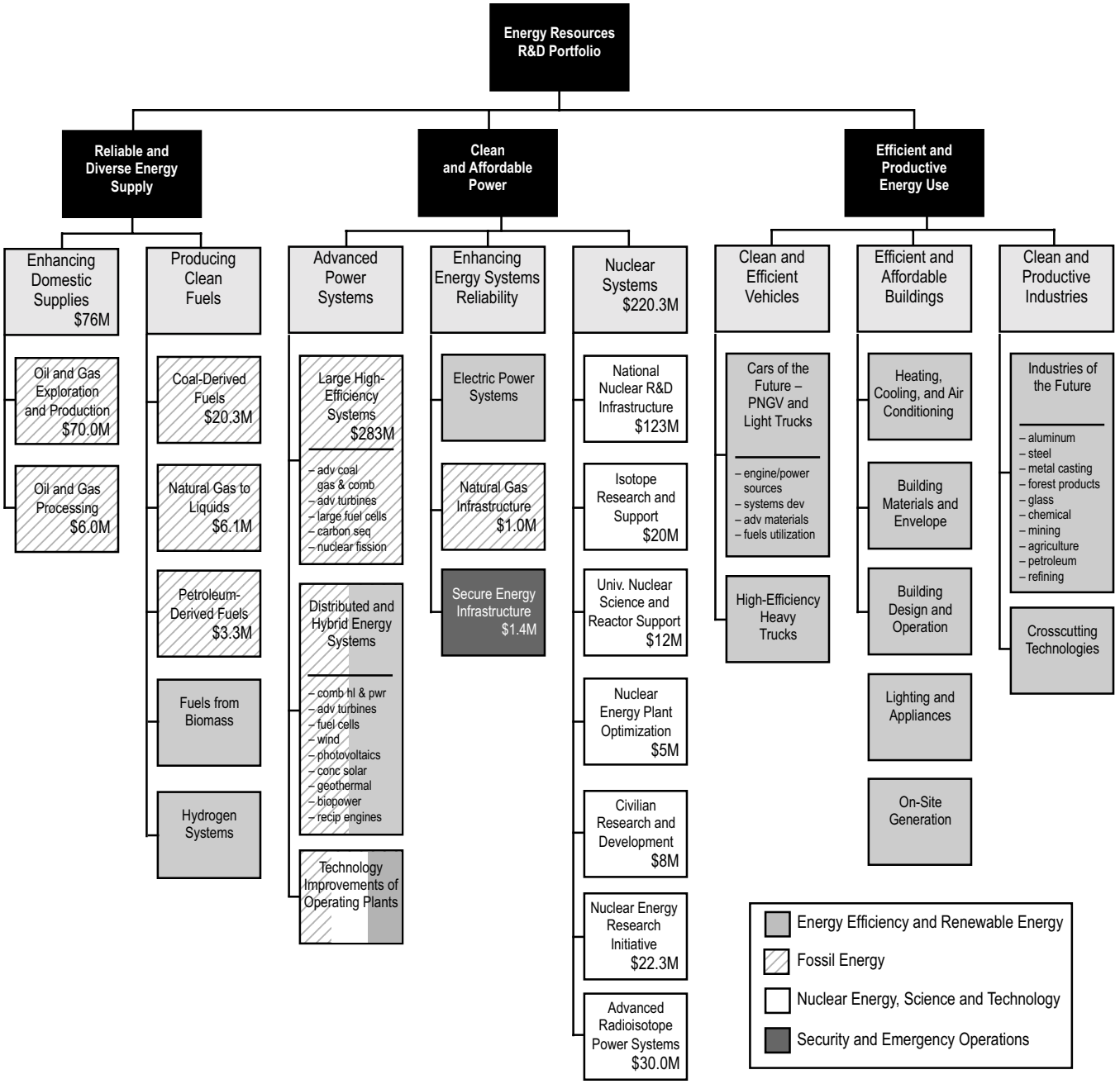
6. The difference between the total funding level reported by the Nuclear Energy program office and the Idaho Environmental and Engineering Laboratory reflects the move of the Naval Reactors program out of the Nuclear Energy office into an independent office in the National Nuclear Safety Administration. Funds for the Naval Reactor programs are not reported in the Mission Analysis section of this report, and the two Naval Reactor laboratories were not profiled. The Idaho Field Office continues to carry the Naval Reactor funds in the Nuclear Energy account.

Energy Resources

General Goal (From *U.S. Department of Energy Strategic Plan)*: Promote the development of energy systems and practices that will provide current and future generations with energy that is clean, efficient, reasonably priced, and reliable.

The Energy Resources (ER) goal covers all aspects of domestic energy from fuel supply through end use. This goal is effectively advanced through a variety of approaches, including the development of improved energy technologies and standards, energy-related

Figure 2. Energy Resources Business Lines



Note: The Office of Energy Efficiency and Renewable Energy did not provide data for this report; therefore, totals could not be calculated. Reported data is FY 2000 Budget data ($ millions)

information, policies, legislation, regulation, international cooperation, and the maintenance of emergency oil reserves. The Energy Resources general goal is supported by five objectives, as follows:

- To promote reliable, affordable, clean, and diverse domestic fuel supplies.
- To promote reliable, affordable, and clean transformation of fuel supplies into electricity and related products.
- To increase the efficiency and productivity of energy use, while limiting environmental impacts.
- To inform public policy makers, energy industries, and the general public by providing reliable energy information and analysis.
- To cooperate globally on international energy issues.

The Energy Efficiency and Renewable Energy program office did not provide data for this report.

Environmental Quality

General Goal (From *U.S. Department of Energy Strategic Plan)*: Aggressively clean up the environmental legacy of nuclear weapons and civilian nuclear research and development programs at the Department's remaining sites, safely manage nuclear materials and spent nuclear fuel, and permanently dispose of the Nation's radioactive wastes.

The Environmental Quality goal is supported by three objectives that are closely aligned with the Department's budget structure. The first objective is to clean up sites that were involved in nuclear weapons production. The second objective is to dispose of spent nuclear fuel and high-level radioactive wastes, and the third objective is to manage waste generated by the uranium enrichment process used to support the nuclear weapons complex and the civilian nuclear power industry.

Explanatory Notes for Environmental Quality

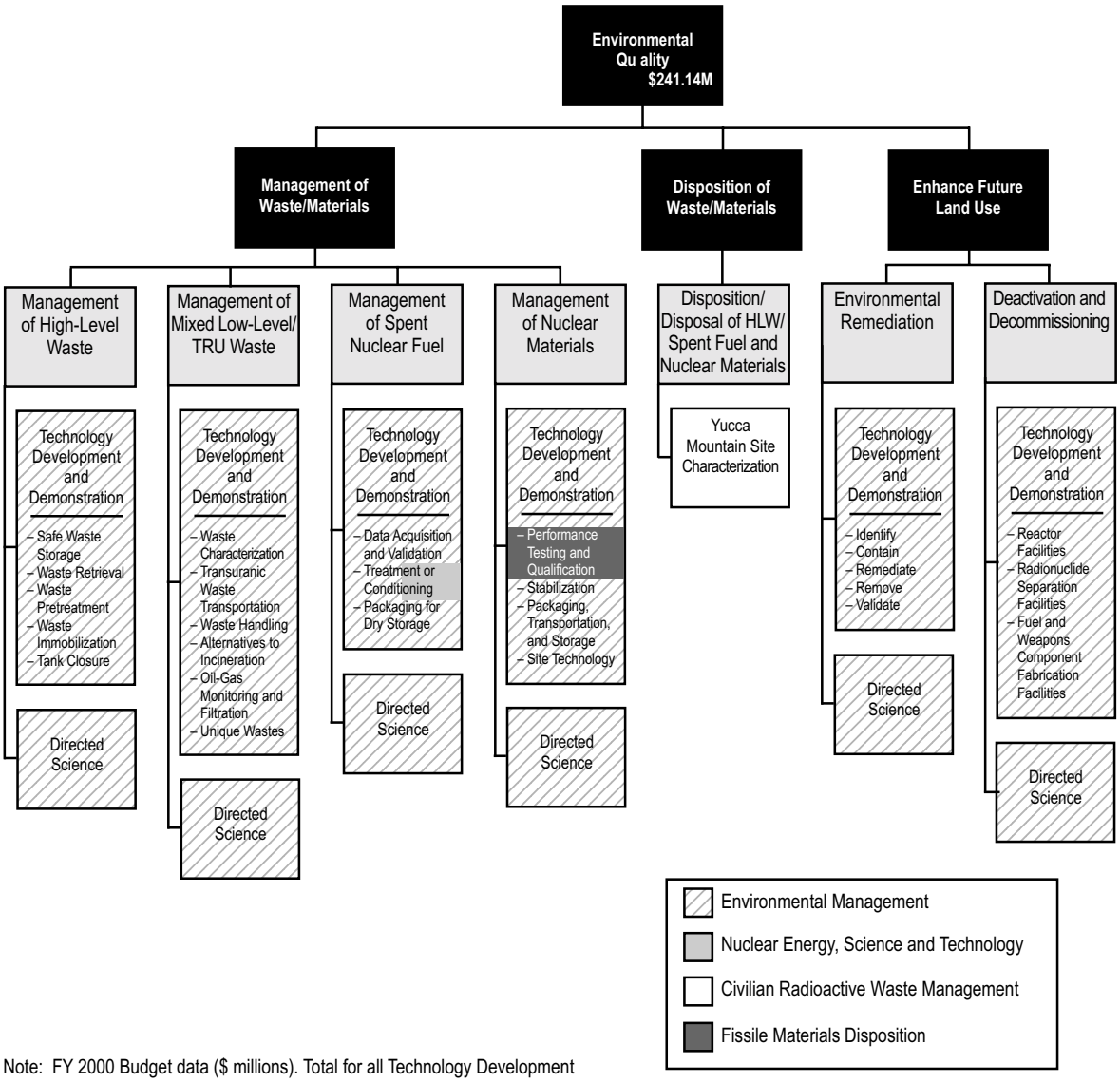
The Office of Environmental Management (EM) supports a number of programs. These programs are listed individually in the Environmental Quality R&D Portfolio, as can be seen in the chart reproduced here. For the purposes of this mission analysis, EM chose to combine a number of R&D activities under a "Technology Development and Demonstration" heading. For each program area presented in the Mission Analysis for the Environmental Quality Mission Analysis, two R&D activities are listed, titled "Technology Development and Demonstration" and "Directed Science."

In preparing the funding input for this Mission Analysis, EM's Office of Budget provided two funding history charts, one for all Technology Development and Demonstration R&D activities in all EM program areas ($209.9 million) and a second chart for all Directed Science R&D activities ($31.24 million) in all EM program areas. There are two Funding History charts, one for Technology Development and Demonstration activities and one for Directed Science activities. The funding history is repeated on each sheet as appropriate.

While a single funding history chart is used for all Technology Development and Demonstration activities, the distribution of laboratory-academia-industry performers is unique for each program area R&D activity. The same holds true for each program area R&D activity in the Directed Science program area

It should also be noted that the Office of Nuclear Energy, Science and Technology has transferred the bulk of depleted uranium stewardship responsibilities to the Office of Environmental Management. Specific R&D activities related to the nuclear fuel cycle that were previously assigned to the Environmental Quality business line will be reassigned to the Energy business line in the next update of the DOE Strategic Plan and of the R&D Portfolio document.

Figure 3. Environmental Quality Business Lines



Note: FY 2000 Budget data ($ millions). Total for all Technology Development and Demonstration programs was $209.9 million. Total for all Directed Science programs in the Environmental Quality mission area was $31.24 million.

National Security

The offices of Defense Programs and Defense Nuclear Nonproliferation developed separate charts to assist in delineating their R&D Activities. An overview is provided below. Additional charts are provided for the two subsections of this mission area. The Naval Reactors program did not provide data for this report.

General Goal (From *U.S. Department of Energy Strategic Plan)*: Enhance national security through the military application of nuclear technology and reduce the global danger from weapons of mass destruction.

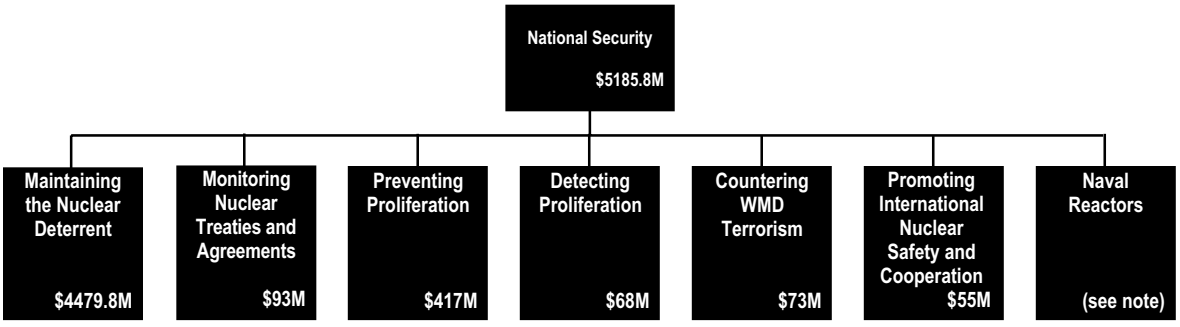
DOE, through the National Nuclear Security Administration, is responsible for the military application of nuclear technology. In the Department, this encompasses activities to maintain the safety, security, and reliability of the nuclear weapons stockpile and the Naval Nuclear Propulsion Program. To reduce the global danger from weapons of mass destruction, the Department provides expertise and develops capabilities to detect and prevent the proliferation of materials, technology, and expertise related to nuclear, chemical, and biological weapons. DOE is also responsible for eliminating the surplus weapons-usable plutonium and highly enriched uranium of the United States and assisting Russia in similar endeavors.

Defense Programs

Changes and New Initiatives in the Defense Programs Stockpile Stewardship Program

Prior to 1992, underground nuclear testing was the principal means to assure the performance of weapons systems and to benchmark design codes used in the assessment of weapons safety, reliability, and performance. Maintaining confidence in the nation's nuclear deterrent in the absence of nuclear testing is a complex, resource-intensive scientific and technological challenge, and is the primary focus of DP's Stockpile Stewardship Program (SSP). A successful SSP requires a large investment in new technology

Figure 4. National Security Business Line



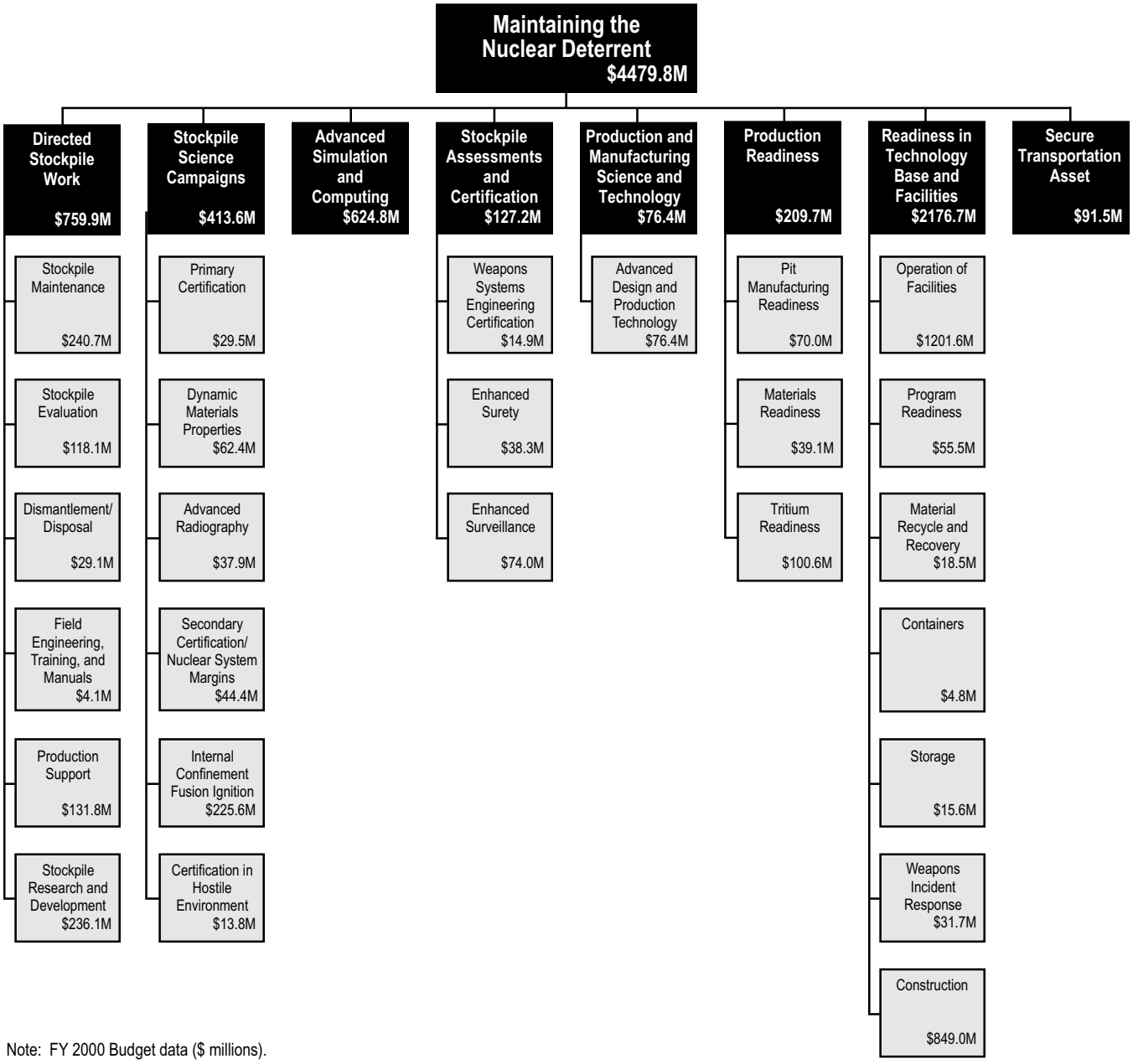
Note: FY 2000 Budget data ($ millions). Budget data for Naval Reactors is not included in total; Naval Reactors program is not included in Mission Analysis. The "Promoting International Nuclear Safety and Cooperation" program area was not included in the FY 2000 National Security Portfolio.

and research during the next few years to develop and validate science-based methods to ensure the safety, security, and reliability of the nuclear-weapon stockpile.

Program Goals and Organization—The Business Model

The highest priority of the SSP is to ensure the operational readiness of the U.S. nuclear weapons stockpile. Since 1999, the National Nuclear Security Administration (NNSA) Office of Defense Programs (DP) has undertaken a major shift in program management strategy and budgeting process, resulting in the adoption of a business model for R&D management and, in FY 2001, the adoption of a new set of budget and reporting (B&R) codes. This has resulted in significant changes to the organizational structure of the SSP

Figure 5. Defense Programs



Note: FY 2000 Budget data ($ millions).

relative to previous years. The SSP is now organized into three focus areas: (1) Directed Stockpile Work (DSW), designed to ensure that stockpiled weapons meet military requirements, (2) Campaigns, designed to provide the science and engineering capabilities needed to meet ongoing and evolving DSW requirements, and (3) Infrastructure (Readiness in Technical Base and Facilities, (RTBF) that is required for stockpile work and computational and experimental facilities at the DP laboratories and the Nevada Test Site. DP also has adopted the establishment of a rigorous planning process for each of these areas that clearly lays out programmatic milestones to be achieved within each.

The DP "Boxology" (Figure 5) expands this functional description in terms of the new program management system. Although the system is being first implemented in FY 2001, estimated funding figures are provided for FY 2000. Further historical understanding may be obtained from the R&D Portfolio and past DP Budget documents, which provide the antecedents for the present program.

This change in approach responds to important drivers that DP presently faces, including weapon refurbishments starting in FY 2006, an aging workforce in the nuclear weapons complex, and an aging stockpile that must be maintained. It also responds to the need for intensive internal and external review to ensure that the program will achieve its goals, while preserving the institutional viability of the laboratories, production plants, and the test site.

Within these three areas, R&D primarily is focused in DSW and Campaigns, which are multiyear research-intensive initiatives that are designed to resolve DP's highest priority stockpile-related scientific issues

Defense Nuclear Nonproliferation

Activities within the Office of Defense Nuclear Nonproliferation (NN) shown in Figure 6 are related to the objectives of Monitoring Nuclear Treaties and Agreements, Preventing Proliferation, Detecting Proliferation, Countering Weapons of Mass Destruction Terrorism, and Promoting International Nuclear Safety and Cooperation. As demonstrated in the Mission Profiles section of the report, activities are coordinated across the NN office to support the goal of reducing the global danger from proliferation of weapons of mass destruction.

Based in the National Nuclear Security Administration (NNSA) in DOE, the Office of Defense Nuclear Nonproliferation is a national office with global reach that brings together the scientific, technical and operational expertise in the Department and the national laboratories to address one of the gravest dangers to U.S. national security today, the proliferation of nuclear, chemical and biological weapons.

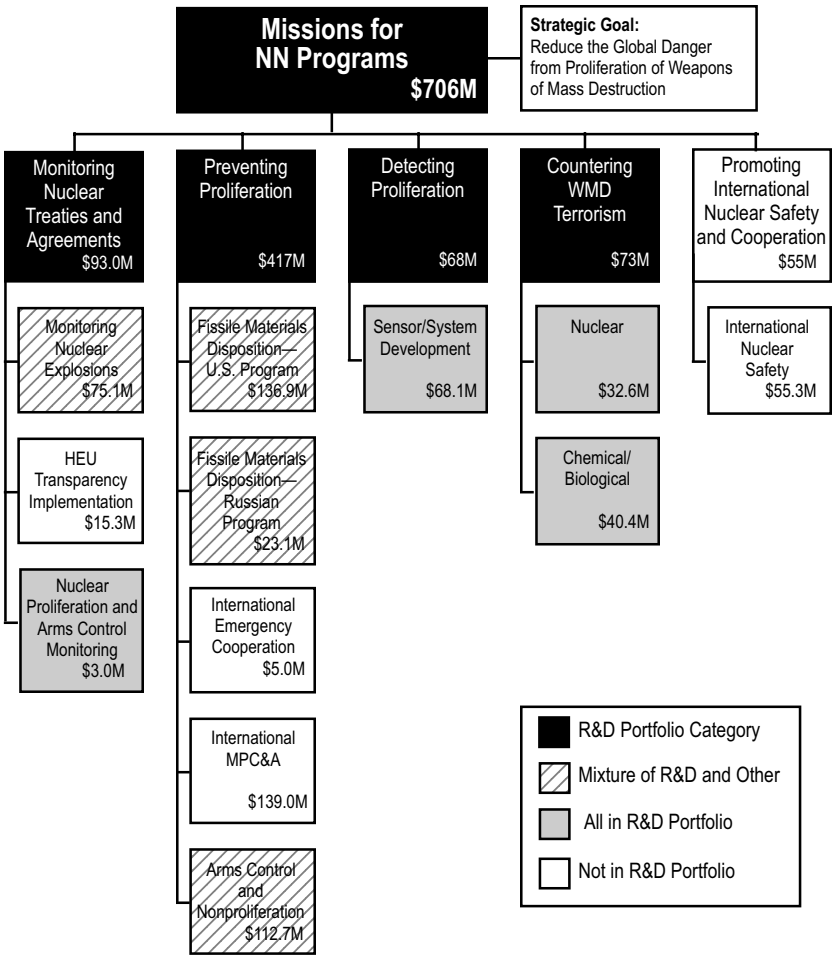
NN contributes to U.S. government efforts to reduce proliferation dangers by:

- Partnering with Russia and other former Soviet states to secure weapons of mass destruction materials and expertise.

- Working with others to strengthen legal and institutional nonproliferation norms.
- Building technologies to detect poliferation activities and advance arms control.
- Promoting the safe use of nuclear power.

On these four pillars, the Office of Defense Nuclear Nonproliferation is addressing immediate needs, developing lasting solutions, and assuring our ability as a nation to remain vigilant.

Figure 6. Nuclear Nonproliferation Business Lines



Note: FY 2000 Budget data ($ millions).

Science

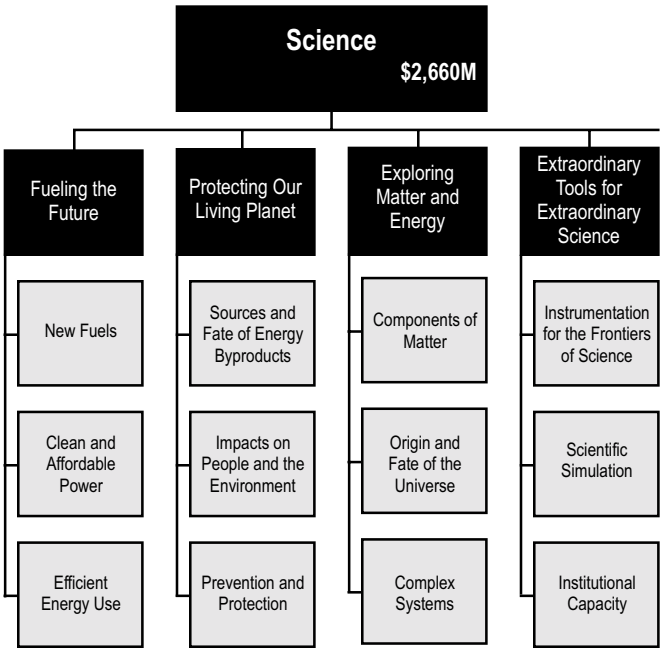
General Goal (From *U.S. Department of Energy Strategic Plan)*: Advance the basic research and instruments of science that are the foundations for DOE's applied missions, a base for U.S. technology innovation, and a source of remarkable insights into our physical and biological world and the nature of matter and energy.

DOE science programs lead the Nation in many of the physical sciences and contribute major advances in the biological, environmental, chemical, and computational sciences. These programs extend the frontiers of scientific knowledge in service to DOE's applied missions in energy resources, environmental quality, and national security, and in support of a fundamental science mission to explore the nature of matter and energy. The Department's programs directly support award-winning researchers, as well as provide access for many other scientists who, sponsored by other agencies, universities, not-for-profit institutions, and companies, utilize the Department's premier instruments of science for the benefit of the Nation.

Explanatory Notes for Science

As the Nation's third largest government sponsor of basic research, DOE makes investments that push the envelope of fundamental knowledge, attempting to unravel some of the most complex and stubborn scientific mysteries. To this end, DOE is a recognized leader in many of the *physical sciences* and performs mission-related research with substantial contributions in the fields of *computation, biology,* and *environmental* sciences. Powerful accelerators, light sources, neutron beam facilities, plasma and fusion science facilities, genome centers, and advanced computational centers are just some of

Figure 7. Science Business Lines



Note: Because investments appear in multiple research areas, there are instances of multiple counting, and research area totals do not sum to the overall Science business line budget.

the major instruments of science that distinguish DOE's capabilities and enhance the Nation's science base.

Applying these unique capabilities, DOE provides the scientific foundations that

- Advance new options for clean and affordable energy.
- Improve understanding of and creates new options for managing the adverse health and environmental impacts associated with energy production and use.
- Provide deep insights into the nature of energy and matter—and new ways to control them.
- Equip our Nation with some of the premier instruments of science.

The science performed by DOE, totaling approximately $2.7 billion in FY 2000, is carried out at DOE national laboratories, colleges and universities, and by industry. Roughly 72 percent of funding goes to the national labs, both for research and for the construction and operation of many of the premier scientific instruments that serve the broader science community. For the remaining funds, approximately 23 percent are dedicated to universities and 5 percent to industry, mostly for research. The Office of Science (SC), the program responsible for the science mission of DOE, thus has a substantial stake and investment in the national laboratories, including multi-program laboratories, program-dedicated laboratories, and mission-specific labs.

Recently, DOE completed an intensive effort to rethink how it approaches, analyzes, plans and describes its research in a long-range strategic context. This "portfolio" approach resulted in a strategic framework for Science that cross cuts traditional science programs and illuminates both new challenges and opportunities at the intersecting boundaries of science disciplines. The science section in this report adopts the same crosscutting framework, based on twelve major organizing themes for DOE science. These are shown in the figure below.

Although the framework offers many advantages, one of the disadvantages is that it does not support a one-for-one linkage with the science budget structure. Thus, a somewhat complex methodology was developed to explore the relationship that exists between the budget structure and the framework. The methodology involves multiple counting of research projects and the use of subjective weighting factors. Final estimates provide only some perspective of the multidimensionality of each lab's basic research. At best, this is an imprecise analytic tool and the resulting estimates should not be construed as budget-quality. Recognizing the inherent limitations in any such weighted, multiple counting method, and recognizing that resulting dollar estimates for each science theme would be far in excess of actual budget totals, only the relative contributions of each lab are presented, expressed as a percentage.

Argonne National Laboratory

Laboratory Information

Location: Argonne, Illinois; Idaho Falls, Idaho
Number of Full-Time Equivalent Employees: 3,950
Scientific and Technical Degrees: 800 Ph.D's; 1,100 Bachelor's/Master's
Contractor: University of Chicago
Accountable Program Office: Science
Field Office: Chicago Operations Office
Web Site: http://www.anl.gov

Funding Sources

Science: $212.1 million
Nuclear Energy: $79.2 million
Energy Efficiency and Renewable Energy: $37.7 million
Environmental Management: $24.0 million
National Security and Nonproliferation: $36.0 million
Fossil Energy: $3.8 million
Other DOE: $ 14.2 million
Non-DOE: $69.3 million

Total Funding: $476.3 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

Argonne is a multiprogram national laboratory with emphasis on facilities for materials-related research and nuclear physics, on development of nuclear technology, and on energy-efficient technologies for the transportation, utility, and industrial sectors. Founded in 1946 as successor to the Metallurgical Laboratory at the University of Chicago, Argonne's initial mission was fission power systems; Argonne conceived most of the nuclear reactor systems now in worldwide use. Current scientific programs emphasize basic energy sciences, computer science, bioscience, and nuclear physics. The Advanced Photon Source, recently completed, is a major national research facility that provides super-intense x-ray beams for research in virtually all the physical and life sciences and in many critical technology areas. Other major user facilities include the Intense Pulsed Neutron Source for materials research and the ATLAS facility for nuclear physics. Much Laboratory work involves close collaboration with other Departmental laboratories. Research and development partnerships with industry and universities strengthen research programs and facilitate transfer of technology to industry. Argonne is the only multiprogram laboratory in the Midwest, and over 40% of its industrial partners are located in six midwestern states.

Distinctive Competencies and Major Facilities

Major Research Facilities:

— **Advanced Photon Source.** Most powerful U.S. source of "hard" x-rays for research—basic and applied—across many disciplines, including materials science, physics, chemistry, biological and life science, earth and environmental science, and medical applications (2,030 qualified users).

— **Structural Biology Center.** Nation's fastest and most powerful user facility for advanced protein crystallographic research in support of biomedical, pharmaceutical, and biotechnology goals; located at the Advanced Photon Source.

— **Intense Pulsed Neutron Source.** Nation's most productive facility of its kind for studying sample structures and dynamics, for materials science and other fields; responsible for instrument development for the Spallation Neutron Source.

— **Argonne Tandem-Linac Accelerator System.** Nation's leading center for research on nuclear structure using heavy ions, up to uranium (ATLAS).

— **High-Voltage Electron Microscope Tandem Accelerator Facilities.** Electron microscopes uniquely set up to study the effects of ion beam irradiation -- nation's only facility for measuring effects at atomic scales as they occur.

— **Cloud and Radiation Testbed.** Unique, highly instrumented research complexes for studying atmospheric phenomena. First site, "Southern Great Plains," including Atmo spheric Boundary Layer Experiments, was built and operated by Argonne; oversight was extended to Alaska and Pacific sites.

— **Nuclear Facilities.** Extensive facilities for conditioning spent nuclear fuel, examining hot nuclear fuel, in-pile transient overpower testing, nuclear-critical experiments, and neutron radiography.

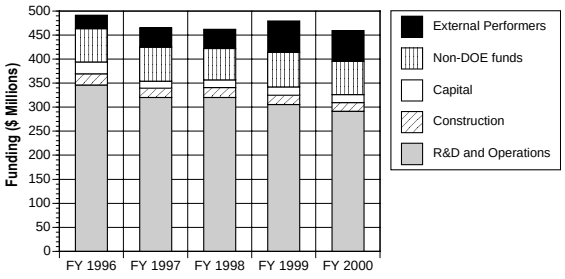
— **Engine Research Facility** for diesels; **Advanced Powertrain Test Facility** for hybrid-vehicle components; vehicle system technologies.

— **Electrochemical Analysis and Diagnostics Laboratory.** Facility supporting development of the next generation of storage batteries and fuel cells.

Distinctive Competencies:

— **Characterization, Synthesis, and Theory of Materials; Accelerator Physics and Technology; Comprehensive Science and Engineering Expertise in Fission Reactor Systems; Modeling, Simulation, and Visualization of Complex Systems; and Structural Biology, Genome Analysis Technology, and Biotechnology.**

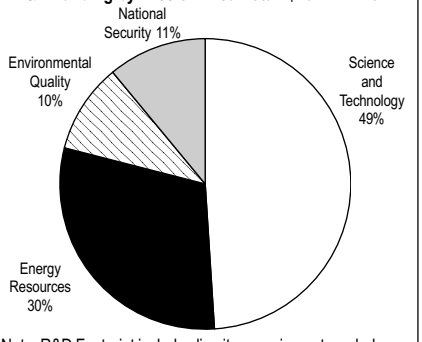
Funding by Activity



Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

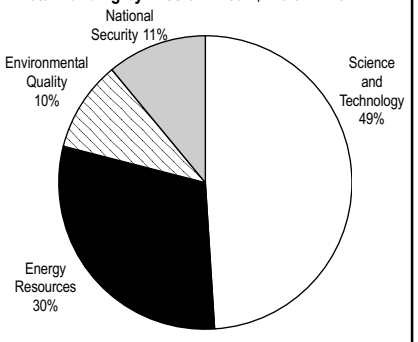
Funding by Mission Area

R&D Funding by Mission Area Total: $462.1 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $476.3 million



Note: Mission Footprint excludes remediation funds.

Argonne National Laboratory

Key Research and Development Activities

Science and Technology Mission: Experimental and theoretical work in the physical and life sciences, with major research programs in advanced techniques for x-ray and neutron science, high-performance computing, structural biology and genome analyses, synthesis of advanced materials, and studies of nuclear structure far from stability.

– X-ray science and technology: High-brilliance radiation sources producing hard x-rays; advanced nano-focussing optics, instrumentation for sub-microsecond time-resolved studies, innovative techniques for performing nuclear and high-energy x-ray scattering, and development of coherent-radiation sources.

– Neutron science and technology: Spallation sources, including development of moderator and target systems; instrumentation, including lead lab for Spallation Neutron Source experimental systems; studies of structure and dynamics in materials, including high-temperature superconductors.

– Materials science: Nanoscale materials fabrication and structural and physical characterization; high-temperature superconductivity, especially vortex physics; magnetic materials, including thin films; complex oxides; defect science; interfacial phenomena; surface science and electrochemistry; granular materials; ceramics; ultracapacitors.

– Chemical sciences: Radiation and photochemistry; heavy-element separation science; electron transfer and photosynthesis; the chemical physics of combustion processes; heavy-hydrocarbon chemistry; metal cluster chemistry; fluid catalysis; advanced battery science.

– Computing sciences: Advanced technology development in computational algorithms and methods; software libraries; parallel and distributed computing; tools for collaboration; visualization; large-scale data management.

– Nuclear physics: Low-energy heavy-ion physics, largely performed at the Laboratory's ATLAS facility; medium-energy nuclear physics, emphasizing use of lepton beams at Fermilab, Jefferson Laboratory, and DESY; nuclear theory, focusing on understanding hadronic and nuclear structure, reactions, and dynamics; technology development for the Rare Isotope Accelerator.

– Physics of elementary particles: Calorimeters and other large detector components (including collaborations with Fermilab for the Collider Detector Facility and with Brookhaven National Laboratory and Lawrence Berkeley National Laboratory for ATLAS at the LHC); collider physics; neutrino oscillations (including detectors for the MINOS experiment being conducted with Fermilab); advanced acceleration methods.

– High-throughput protein crystallography, including robotic preparation of expressed proteins and crystals; protein engineering; genome analysis and related technology, including a novel biochip technology.

– Atmospheric research: Development and instrumentation of field sites; atmosphere-surface exchange research; atmospheric chemistry; climate change modeling; atmospheric boundary layer measurements; regional tropospheric modeling.

Energy Resources Mission: Advanced energy technologies, with emphasis on innovative concepts, technology, and safety for civilian nuclear power; conditioning of DOE-owned spent fuel for disposal; efficient energy utilization in the transportation and industrial sectors; and supporting research in materials, chemical, and electrochemical technologies.

– Nuclear technologies and nuclear safety, including innovative concepts for next-generation reactors and R&D on fuels and materials, safety technologies, and application of advanced computing; collaboration with INEEL as the DOE-Nuclear Energy lead laboratory for nuclear reactor technology; domestic and international collaborative R&D for the Nuclear Energy Research Initiative and the International Nuclear Safety Center.

– Electrometallurgical technology for conditioning DOE-owned spent fuel, including development and operation of equipment and processes for EBR-II spent fuel; development and testing of waste forms.

– Transportation technologies: Advanced batteries and fuel cells; alternative fuels and hybrid vehicles; innovative engine emissions control; sensors; thermal management; tribology; intelligent transportation systems.

– Industrial process technology: Materials and waste recycling, esp. recovery of polystyrene and ABS; sensors and instrumentation for process control, esp. nondestructive evaluation of materials and systems; biochemical process development.

– Applied superconductivity, especially development of high-temperature superconducting wire for the electric power industry and flywheels for energy storage.

Environmental Quality Mission: Technology for nuclear and chemical waste management, nuclear decontamination and decommissioning (D&D), industrial waste management, and site restoration.

– Advanced technologies for mixed waste treatment, especially for waste containing transuranics or requiring remote handling ; waste form development.

– Advanced technologies for D&D: Demonstration of novel technologies in large-scale projects, including advanced cutting techniques, effluent control technologies, instrumentation, and chemical/mechanical decontamination, esp. soil washing.

– Site characterization; land reclamation and restoration technologies (including analytic applications of geographic and spatial information systems, data visualization, and Argonne's expedited site characterization process for sites contaminated with hazardous wastes).

– Environmental assessment and modeling: Site-specific environmental impact and remediation studies; modeling of contaminant transport.

– Environmental stewardship: Advanced approaches and technologies to assure long-term stewardship of residual contamination at DOE sites; decision tools; risk models; information systems; monitoring systems.

– Risk analysis: Assessment of environmental regulations and policies and health and ecological risks, including NRC studies.

National Security Mission: Technologies for nonproliferation.

– New reduced-enrichment fuels for research/test reactors, with conversion assistance to operators; systems for protection/control/accounting of nuclear materials; nuclear detection technologies.

– Critical infrastructure assurance: Analyses and systems development to protect domestic energy-related infrastructure (electricity, oil, gas, and water) and other infrastructures (airports, buildings) from physical and cyber disruption; disruption management systems; consequence management.

Argonne National Laboratory

Significant Accomplishments

Science & Technology

— **Developing the Advanced Photon Source (1987-2000):** The $812 million Advanced Photon Source (APS) is one of three third-generation synchrotron radiation facilities in the world and the only one in the Western Hemisphere. The APS provides stable, reliable, high-brilliance, hard x-ray beams for use in research -- both basic and applied -- across a broad range of disciplines, including materials science, physics, chemistry, biological and life sciences, earth and environmental science, medical applications, and specialized instrumentation development. Researchers at the APS already have shown that they can study smaller samples in shorter time periods, delineate the structures of protein crystals that are smaller and more complex, image processes in real time that occur too rapidly for earlier technologies, and develop new understanding of the surfaces and interfaces of materials.

— **Structural Biology Center (1999-2000):** In 1999, more new protein structures were determined at Argonne's Structural Biology Center than at any other synchrotron beam line in the world. Altogether, 85 protein structures have been determined at this biosciences national user facility at the APS, and the determination rate is increasing rapidly.

— **Biochip Technology (2000):** Scientists at Argonne and the Engelhardt Institute of Molecular Biology are utilizing a DNA-based microchip ("biochip") to analyze drug resistance in tuberculosis in Russia, achieving 95%-successful diagnosis in hours rather than weeks. Already detected are 30 of the 40 mutations responsible for resistance to the drug rifampicin.

— **Next-Generation Network Prototype (1997-98):** With the University of Southern California's Information Sciences Institute, Argonne developed the GUSTO computational grid testbed. One of the largest computational environments ever constructed, GUSTO links the world's most advanced computer resources, as well as data archives, virtual reality displays, and scientific instruments. GUSTO received the Third Annual Global Information Infrastructure Award in 1998, for pushing the technological envelope and providing a prototype for next-generation networking.

— **Super-Heavy Nuclei (1997-98):** Research at the ATLAS heavy-ion accelerator, using the state-of-the-art gamma-radiation detector Gammasphere, established that a nucleus of the heavy element nobelium has a highly deformed, football-like shape that stabilizes the nucleus against fission. This important discovery is on the research path toward confirming theoretical calculations that predict the existence of super-heavy nuclei.

— **Artificial Intelligence (1997):** Argonne used automated reasoning to solve the Robbins problem, which had puzzled some of the world's leading mathematicians and logicians for more than six decades. The solution was cited by AI Magazine as one of five major recent accomplishments in artificial intelligence.

— **Reducing Nuclear Waste Volume (1980-94):** Chemists at Argonne and the Westinghouse Hanford Company developed the TRUEX process, by which transuranic elements, the most toxic kind of radioactive waste, can be separated from other liquid wastes. As a result, the volume of waste requiring costly vitrification and burial can be reduced more than 100-fold.

Energy Resources

— **High-Temperature Superconductors (1990-2000):** Argonne is an international leader in explaining the science of vortex dynamics in high-temperature superconductors and in understanding its magnetic implications for practical applications. This work has received both extensive scientific recognition and a number of application awards. Its first practical deployment was at Southwire Co. in Feb. 2000.

— **Nuclear Reactor Safety (1990-2000):** Over the past decade, major Argonne nuclear safety experiments strengthened confidence in the safety of power reactors around the world. Seven experiments sponsored by an international consortium demonstrated the coolability of debris from a severe accident. Argonne's International Nuclear Safety Center undertakes joint safety R&D with its Russian counterpart and is assisting in projects to improve the safety of Soviet-designed reactors.

— **Transportation R&D (1997-2000):** Argonne developed the first technology for diesel engines that allows simultaneous reductions in emissions of both particulates and nitrous oxides. The Laboratory also developed and demonstrated an on-vehicle processing technology for reforming gasoline or other fuel into hydrogen for fuel cell propulsion, a technology that could enable 80 miles per gallon using the current gasoline station infrastructure. Transportation awards include PNGV medals for fundamental research in NOx catalysis (1997) and for a fuel cell reformer (1998), and R&D 100 awards for a nearly frictionless carbon coating (1998) and diesel emission reduction technology (1999).

— **Recycling Technology (2000):** An Argonne auto-shredder-residue recycling process, licensed internationally, is the basis for a Belgian plant now under construction. An aluminum-salt-cake recycling process is in pilot-plant demonstration. Argonne won a Discover Award for Technology Innovation for froth flotation recovery of ABS plastics and an R&D 100 award for a polyurethane foam recycling process.

— **DOE Spent-Fuel Conditioning (1996-2000):** Argonne's electrometallurgical technology for spent fuel conditioning was successfully demonstrated using EBR-II spent fuel. It removes and separates short-lived fission products from long-lived transuranic elements to facilitate long-term disposal. Broader application to DOE spent fuel could save billions of dollars.

Environmental Quality

— **Nuclear Facility D&D (1996-98):** At the CP-5 reactor, the Department's first large-scale demonstration of technologies for decontamination and decommissioning (D&D) of nuclear facilities was completed. Twenty-three novel D&D technologies were successfully demonstrated for potential future use.

— **Expedited Site Characterization (1998):** Argonne's "expedited site characterization" process was made a voluntary consensus standard of the American Society for Testing and Materials. An application to contamination by explosives, organic solvents, and heavy metals at the Pantex Plant is estimated to have saved $14 million. Commercialization of the Laboratory's proprietary QuickSite® system is under way.

— **Radioactivity Risk Evaluation (1985-2000):** Argonne's RESRAD is the only code designated by DOE for evaluating radioactivity at contaminated sites; more than 300 sites have benefitted. NRC and EPA use RESRAD in evaluations for licensing and rule making.

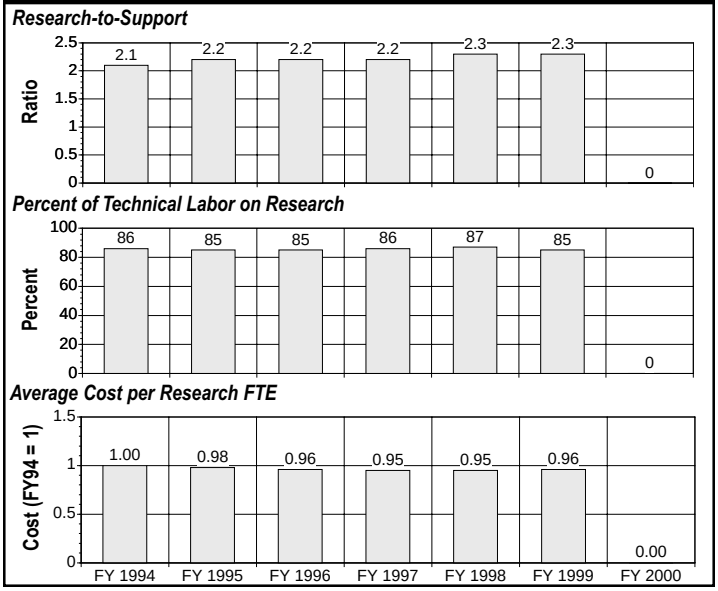
Argonne National Laboratory

Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

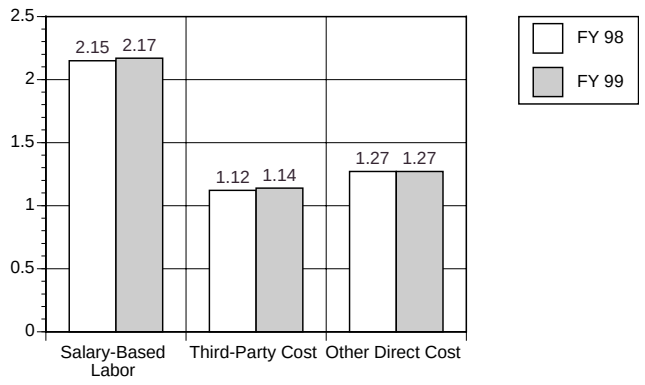
Argonne works extensively in partnership with universities, industrial firms (especially in the Midwest), and international organizations. Collaboration with other DOE labs is widespread (as summarized in the Appendix to Argonne's 2000 Institutional Plan). Non-DOE federal agencies support research that complements DOE work and utilizes Argonne capabilities. Illustrating Argonne's highly diverse partnerships are the following:

Category/Mission	*Partner*	*Description*
Science & Technology	University faculty & grad students at Argonne's user facilities	Over 1200 university faculty and graduate students are users at the Advanced Photon Source, the Intense Pulsed Neutron Source, the Argonne Tandem-Linac Accelerator System, and other Argonne research facilities.
	28 U.S. corporations	Development and operation of multimillion-dollar experimental stations at Argonne's Advanced Photon Source (APS).
	ORNL; BNL, LBNL, LANL, TJNAF	The Spallation Neutron Source construction project.
	6 universities	The Midwest Center for Structural Genomics develops and implements integrated technologies for rapid, large-scale determination of new protein structures.
	Northwestern U.; PNNL; 10 industrial cos.	The NSF-DOE Institute for Environmental Catalysis utilizes the unique laser photocher facility for time-resolved x-ray absorption spectroscopy at the Basic Energy Sciences Synchrotron Radiation Center at the APS.
	Multiple DOE labs, many univs., internat'l orgs.	High energy physics detector collabs.: (1) ATLAS at Europe's CERN; (2) ZEUS at DESY in Germany; (3) Collider Detector at Fermilab; (4) Soudan-2 in Minnesota; (5) MINOS.
Energy Resources	Over 10 Russian research institutes; PNNL, INEEL	International Nuclear Safety Center for fission power plants and other nuclear facilities.
	Several universities	Research on advanced engines in conjunction with Argonne's Advanced Powertrain Test Facility.
	American Superconductor, ORNL, LANL, NIST, 2 univs.	R&D on high-temperature superconductors.
Environmental Quality	Many univs.; DOE labs; non-DOE gov., private, and internat'l. orgs.	DOE's Atmospheric Radiation Measurement Program uses field measurements, novel instrumentation, and model development for deeper understanding of climate change. DOE's Atmospheric Chemistry Program undertakes major field research on regional and urban air quality.
Energy Resources/Environmental Quality	Many industrial firms & other private orgs.	More than 30 cooperative R&D agreements ($23M/yr); more than 130 Work for Others projects ($14M/yr).
National Security	ORNL, PNNL, LLNL, LANL, SNL, SRS	DOE's program Cooperation on Nuclear Export Controls in Russia and the NIS.
All mission areas	Many federal agencies	Research for the Depts. of Defense, Agriculture, State, Transportation; Nuclear Reg. Com., FEMA, EPA, NIH, NASA; other agencies (over $50M/yr).
	Universities across the nation	The largest educational program among DOE national laboratories, with 800 undergraduates participating annually. About 175 graduate students do thesis work at the Laboratory.

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Brookhaven National Laboratory

Laboratory Information

Location: Upton, New York
Number of Full-Time Equivalent Employees: 2,981
Scientific and Technical Degrees: 631 PhD, 398 MS/MA, 508 BS/BA
Contractor: Brookhaven Science Associates
Accountable Program Office: Science
Field Office: Chicago Operations Office
Web Site: http://www.bnl.gov

Funding Sources

Science: $296.8 million
Nuclear Energy: $2.4 million
Energy Efficiency and Renewable Energy: $3.9 million
Environmental Management: $11.3 million
National Security and Nonproliferation: $25.8 million
Fossil Energy: $1.0 million
Other DOE: $2.0 million
Non-DOE: $40.6 million

Total Funding: $384.0 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

From its beginning in 1947 as the nation's first peacetime federal laboratory, Brookhaven National Laboratory has served the science community in the Northeastern United States. The Laboratory offers a combination of "big science" facilities and basic science competencies that ensure the relevance of the facilities to the missions of the Department of Energy. Today BNL is a world leader in accelerator-based science and technology. The Laboratory's two large user facilities, the Relativistic Heavy Ion Collider (RHIC) and the National Synchrotron Light Source (NSLS), can probe nearly the entire range of scales - from human-sized to elementary particles - of interest to most areas of physical and biological science. BNL leads the national and international user community in the exploitation of these powerful tools. The Laboratory's Science and Technology mission fosters strong interdisciplinary interactions, highlights the essential connection of our accelerator/source/detector programs to our facilities and future accelerator based facilities, and demonstrates the connection between our discovery-oriented and issue-oriented R&D and our facilities. In 2000 BNL began operation of RHIC, the worlds largest facility for the study of conditions that occurred microseconds after the Big Bang. The first gold collision were detected in June, 2000. Over 4000 scientist from the US and abroad use BNL's facilities, and participate in joint scientific ventures with the staff. This outstanding mix of machines and expertise four times produced work that earned the Nobel Prize.

Distinctive Competencies and Major Facilities

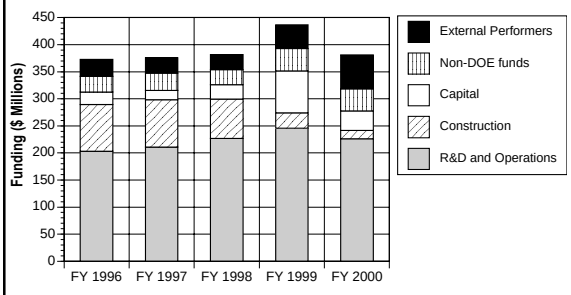
The core competencies are in extraordinary facilities (design, construction and operation), advanced concepts (accelerators, detectors, magnets, sources and instrumentation), quark-gluon plasma and spin physics, the physics of rare process and particles, the physics and chemistry of materials and condensed matter, molecular and structural biology, medical imaging and instrumentation, energy sciences (e.g., combustion and catalysis) and environmental sciences (aerosols, carbon management). BNL also has core competencies in environmental and energy technologies and national security/ non-proliferation. Brookhaven is one of five laboratories contributing to the Spallation Neutron Source, designing, constructing and commissioning the 1 GeV accumulator ring and the beam transports from the linac to the ring and then to the target stations. BNL plays an important role in the Large Hadron Collider Project and subsequent science program, hosting the US participation in the ATLAS detector and managing the construction of the detector, including the computing infrastructure. Ion Accelerator Complex: BNL's unique facilities include **the Relativistic Heavy Ion Collider (RHIC)**, the largest facility for nuclear physics in the US and the most powerful source of heavy ion collisions in the world. RHIC offers a wealth of potential for new discoveries about the most fundamental structure of matter. **The Alternating Gradient Synchrotron (AGS)** is a proton accelerator with the highest intensity high-energy proton beams in the world, and a source of polarized protons for over 800 users. Coupled to the Tandem Van de Graaff, the AGS can accelerate heavy ions, serving as the injector for RHIC, and providing beams for other facilities such as the NASA facility for radiobiology, the Booster Application Facility. The AGS also supports the Brookhaven Linac Isotope Producer, where isotopes are produced for medical applications and research.

Ion Accelerator Complex. BNL's unique facilities include the Relativistic Heavy Ion Collider (RHIC), the largest facility for nuclear physics in the US and the most powerful source of heavy ion collisions in the world. The Alternating Gradient Synchrotron (AGS) is a proton accelerator with the highest intensity high-energy proton beams in the world and serves as the injector for RHIC, as well as a source of polarized protons for over 800 users.

Electron Photon Accelerator Complex: **The National Synchrotron Light Source (NSLS)** is a user facility providing high intensity x-ray, ultraviolet and infrared light to 85 beamlines. Today it provides more than 60% of the nations synchrotron capacity. Researchers in applied sciences, chemical sciences, materials and life sciences from 350 institutions use the NSLS, and it serves as a test bed for "proof of principal" experiments on new source concepts. **The Accelerator Test Facility (ATF)** is a unique user facility for the development of new accelerator concepts. Current R&D effort will form the basis of the next evolution of light sources with the development of short wavelength free electron lasers. **The Laser Electron Accelerator Facility (LEAF)**, using technology developed at the ATF, provides very short (7 picosecond) pulses for basic studies of fast reactions.

Imaging Center: **The Center for Imaging and Neuroscience (CIN)** provides three imaging modalities for studies of the brain; **Positron Emission Tomography (PET)**, **Magnetic Resonance Imaging (MRI)**, and **Single Photon Emission Computed Tomography (SPECT)**. The current activities include research on aging, addiction, and normal brain function.

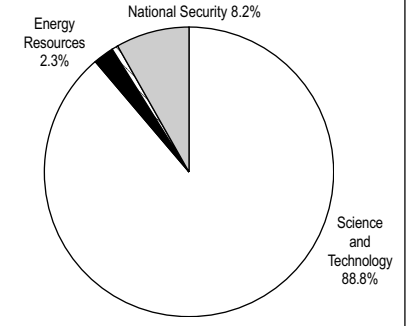
Funding by Activity



Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

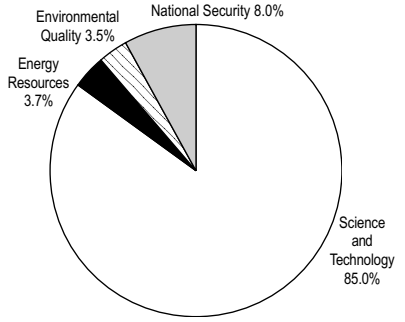
Funding by Mission Area

R&D Funding by Mission Area Total: $312.1 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $384.0 million



Note: Mission Footprint excludes remediation funds.

Brookhaven National Laboratory

Key Research and Development Activities

Science and Technology Mission: BNL's Science and Technology capabilities define its role in the DOE national laboratory system.

Ion Accelerator Complex: The Relativistic Heavy Ion Collider (RHIC) will be in the forefront of nuclear physics and spin physics research for at least the next 10 years, and with a program of continual improvement, well beyond. RHIC provides a full heavy-ion and polarized proton physics program probing the quark-gluon plasma. At the Alternating Gradient Synchrotron (AGS) researchers conduct high priority experiments such as muon g-2 and rare kaon decay, testing the limits of the Standard Model. BNL is expanding the use of the AGS capabilities to other agencies such as NASA for radiobiology studies and National Science Foundation for the Rare Symmetry Violating Processes program. The AGS is an integral tool for the neutron science program, serving as a test bed for Spallation Neutron Source (SNS) target tests. New test facilities will be developed for new approaches and technologies for a muon accelerator/storage ring complex. The Tandem Van De Graaff serves as the heavy ion source for RHIC and a second tandem provides ions for the user community.

Electron-Photon Accelerator Complex: BNL continues to extend the role of the National Synchrotron Light Source (NSLS) as a resource for materials, chemical and biological research. BNL promotes the development of scientific applications of advanced x-ray source facilities and provides facilities for "proof of principal" experiments, continuing its key role in the national R&D program for the next evolution in light sources. Research programs identify new detector and instrument needs, designed and constructed as Advanced Concepts, that assist the staff and users at the facility to further their scientific agendas. BNL contributes to the national effort to develop an x-ray free electron laser by supporting the Linear Coherent Light Source project through the development of advanced accelerator technologies at the Accelerator Test Facility (ATF) and by developing and testing detector systems that would be suitable for an advanced x-ray source. The Laser Electron Accelerator Facility (LEAF) is a key facility for studies of radiation induced chemistry relevant to research in catalysis, combustion and the phenomena of scale (nanoscience). BNL science programs also identify new needs/applications that make full use of or extend the capabilities of BNL's facilities.

Advanced Concepts: BNL conducts cutting-edge accelerator research using the RHIC, AGS, NSLS and ATF. New or improved designs for detectors, magnets, sources and instrumentation to meet the needs of the users and the Lab's basic science programs are designed, developed, tested and implemented. BNL continues to participate in the international collaboration to capture intense beams of muons in an accelerator/storage ring complex and by using AGS as a test bed for new approaches and technologies. The Lab supports the development and construction of the Spallation Neutron Source (SNS) and uses its expertise to develop key elements of x-ray Free Electron Laser sources, using the symbiotic relationship of laser and accelerator technologies. BNL has an aggressive R&D program on magnet requirements for future hadron colliders and muon storage ring/colliders, supports the development of advanced instruments for the US ATLAS Project, neutron detectors and instrumentation for SNS and new fixed target programs at the AGS.

Advanced Computation: Advanced Computation underpins the advancement of science and technology. BNL expects to expand its capabilities in advanced computation to support the BNL programs. The BNL RHIC Computing Facility supports the evolving RHIC Physics program. The Center for Data Intensive Computing accommodates the advanced computation needs for the Lab including developing parallel codes for particle and spin coupling, the study of magnetohydrodynamic effects in targets for the SNS and a future muon collider, and new parallel codes for the study of photon localization in semiconductor lasers. In the future BNL's capabilities will support data mining, visualization and graphics, parallel and distributed computing and networking, and modeling and simulation.

Discovery Oriented Science: BNL is a leader in the nuclear physics of RHIC-based heavy-ion and spin physics. In high energy physics BNL researchers continue to focus on the Standard Model and on rare particles and processes. They also participate in experiments at other facilities such as CERN and Fermilab. BNL is host to the US ATLAS Construction and Computing Projects, and provides oversight management for US scientists participating in ATLAS. The Lab is expanding its cross-disciplinary collaborative research in correlated electron systems, surface and interfacial structures and magnetic systems, relying heavily on the unique facilities and experimental techniques such as x-ray scattering, neutron scattering, powder diffraction and electron microscopy. BNL is emphasizing the phenomena of scale--nanoscience- through collaborations among the physics, chemistry, and biology groups. The Center for Neutron Science will lead a comprehensive program to sustain the world class neutron science capabilities at BNL using the capabilities of the SNS. Basic research also focuses on energy conversion, energy use and alternative energy sources, using the Lab's research facilities and advanced experimental capabilities. Researchers explore catalysis, combustion, radiation-induced chemistry for energy storage, and plant biosynthesis for renewable energy sources. The focus will be on the reactivity and structure correlation of nanoscale materials, which hold considerable promise as chemical and photo-catalysts with properties that can be controlled through particle size, density and chemical environment. LEAF will expedite studies of radiation-induced chemistry relevant to transport in molecular scale devices. In genetics, cell biology and structural biology, researchers characterize gene expression from specific regions of the human brain and from organisms important for carbon management and bioremediation. BNL's user facilities for structural biology are being improved, with emphasis on the efficiency of protein crystallography at the NSLS and the ease of access for all users. Efforts will continue to determine the structures and interactions of biological complexes, improving the methodology of engineering proteins for useful purposes. Radiobiology researchers investigate cellular mechanisms of radiation induced cell damage and the effects of heavy particle radiation, fully utilizing the Booster Application Facility and the radiobiology facility at the NSLS to facilitate this research. BNL also is developing new technologies for determining the complex structure of membrane proteins in native cellular environments.

Issue Oriented Science: The Laboratory uses its unique accelerator facilities for imaging and radiopharmaceutical capabilities to develop new treatments, new diagnostic tools and to study human physiology and the mechanisms of disease in areas of oncology and neuroscience. The Positron Emission Tomography (PET) program in conjunction with the "fast chemistry" capabilities and radiopharmaceutical research activities are a focal point of imaging research in the Northeast. An advanced Magnetic Resonance Imaging (MRI) research capability validates new techniques and investigates the synergistic use of MRI with other modalities to probe molecular mechanisms involved in normal brain function and disease. Researchers continue efforts to understand the atmospheric process that controls the transport, transformation and fate of energy related chemical and particulate matter, to understand global and regional environmental change. The Laboratory is expanding its role in understanding and identifying the sources, distribution and impacts of carbon dioxide in the global environment, applying new tools in molecular biology to determine the carbon uptake by plants and how it adjusts to increases in carbon dioxide in the atmosphere. The new emphasis on the structure of membrane proteins will contribute directly to understanding the environmental consequences of energy generation.

Energy, Environment and National Security Missions: BNL contributes to the DOE missions in energy, environmental quality and national security. In Energy the focus includes fuel cells, thermophotovoltaics, geothermal systems, distributed energy systems and advanced proliferation resistant nuclear reactor fuel cycles. Researchers work on systems for remediating DOE sites and scientist continue to play a role in US domestic and international programs in nonproliferation and national security. In National Security BNL's emphasis is on nuclear safeguards and weapons of mass destruction control; verification and transparency; security related environmental threat reduction; and Russian materials production, control and accounting.

Brookhaven National Laboratory

Significant Accomplishments

Ion Accelerator Complex: The Relativistic Heavy Ion Collider (RHIC) is the world's newest facility for nuclear physics. It began operations in 2000 and the first gold collisions were detected. It also demonstrated that polarized protons could be accelerated and stored in RHIC and the spin polarization preserved during acceleration and rotated at will by the Siberian Snakes (2000). The Alternating Gradient Synchrotron (AGS), one of the most productive high-energy facilities in the world, serves as injector to RHIC and provides capabilities for high-priority, high-energy physics experiments and supports missions at other satellite facilities. The AGS produces a very hight intensity high-energy proton beam. In 1998 the world's largest superconducting magnet went on line at the muon g-2 experiment, and scientists observed the first of two very rare kaon decays. Other notable firsts include: first acceleration of heavy ions to 10 GeV energy range (1986) and the onset of heavy ion fixed target physics; a Nobel Prize for demonstrating the existence of two kinds of neutrinos (1985); a Nobel prize for discovery of CP violation in the decay of neutral K mesons (1980); a Nobel Prize for discovery of the J/psi particle (1976); and discovery of the omega minus hyperon (1964). The AGS was the first accelerator based on the principle of strong focusing, a design now used worldwide.

Electron-Photon Accelerator Complex: National Synchrotron Light Source (NSLS) is one of the most heavily used facilities in the world. In 2000, researchers deciphered the structures of the botulism toxin, the ribosome, P450 an enzyme that performs several important jobs in the human body, and how one cold virus binds to human cells (1999). Earlier accomplishments include: identification of crystal structures of many biological structures, such as that of gp120 (1998), which reveals how HIV virus binds to the receptor; development of the small undulator gap design, which changed the design rules for the next generation x-ray sources (1995); development of projection lithography (1990); development of medical x-ray imaging techniques for mammography (1995) and coronary angiography (1991); development of x-ray microtomography to study fluid flow in rock (1987); development of x-ray lithography by IBM (1983). All modern light sources are based on the unique high brightness lattices developed at BNL (1975, Chasman-Green lattice). At the Accelerator Test Facility, BNL demonstrated High Gain Harmonic Generation (2000) as a concept for new Free Electron Laser, and Staged ELectron Laser Acceleration (STELLA), the first staged acceleration of an electron bunch. The Thomson Scattering Experiment of a laser of the electron beam produces polarized positrons for linear colliders. This experiment is a unique source of picosecond x-rays with an unprecedented number of photons per pulse.

Neutron Facility: The High Flux Beam Reactor had been a major tool for neutron studies in condensed matter and nuclear physics, chemistry, and biology until the permanent shut down in 1999. Significant accomplishments include; developed tin-117m DTPA as a possible treatment for bone cancer (1995); elucidated the mechanism of Adamantaine in the treatment of influenza A (1994), determined the structure of higher order packaging of DNA and nucleosome cores in human cells (1994); determined the structure of plasminogen enabling development of effective intervention in heart attack and stroke patients (1990).

Advanced Concepts: BNL developed the magnet design and construction methods for RHIC, constructing over 2,000 magnets for the RHIC. Other developments include a new state-of-the-art picosecond pulse radiolysis facility, based on BNL-developed laser accelerator technology (1998); the scanning x-ray microscope that enables a wide variety of studies in materials problems(1996); an infrared beamline that formed the basis for beamlines proposed for other synchrotron facilities (1990); and a real-time feedback system to stabilize the entire orbit in a storage ring. (These systems improved the stability at the NSLS by an order of magnitude (1989)). Also developed at BNL: instrumentation and software for quantifying DNA damage in human and plant cells (1987) and a triple bend achromatic lattice using gradients in the bending magnets in 1985 (a design adopted by LBNL for the ALS storage ring). BNL scientist are responsible for a 2 in 1 superconducting dipole (1982) and the Chasman-Green lattice to optimize brightness of synchrotron radiation sources and provide dispersion free straight sections for insertion devices. Third generation hard x-ray sources are based on the Chasman-Green design (1975). The first prototype Positron Emission Tomography (PET) for brain research was developed at BNL (1970), as was the strong focussing concept (1952) for accelerator design. All accelerators are now based on this concept.

Discovery Oriented Science: Over the years researchers have pinpointed the mechanism for UV damage to rice plants (2000); developed a wide array of tags to track proteins and other molecules; demonstrated transfer of molecular hydrogen between two oxidation states of a metal complex via a dihydrogen-bridged intermediate (1998). Earlier researchers bioengineered desaturase, an approach that holds promise for revolutionizing production of feedstocks from plants (1997) and discovered that the longitudinal relaxation rate constant of an NMR signal from a flowing fluid can be manipulated non-invasively. This has promise for the study of blood flow in vivo (1997). Electron transport in stripes in high Tc was discovered in 1995 and primers for deciphering DNA were developed in 1992. This system holds promise for faster sequencing of genomes. In 1987 scientists mapped recombinant inbreds as a way to map genes in plants. This is now used commercially for mapping plant genes. Vectors for selective expression of cloned DNA using T7 RNA polymerase were developed in 1987. In 1986 researchers discoverd the second high-temperature superconductor. Researchers verified the importance of nuclear configuration changes, bridging groups, and solvents in determining electron transfer rates in 1985. This is important in understanding possible ways to harness solar energy. Scientists discovered and characterized the first human enzyme required for DNA repair of damage from ionizing radiation (1983) and DNA mismatch repair (1982). In 1975, researchers discovered and studied charge density waves and incommensurate structures. They earlier established the statics and dynamics of physiosorbed films (1974). The Gallex solar neutrino detector, which showed (1970) that there are fewer neutrinos from the sun than was predicted by theory, was developed at BNL. BNL scientists discovered the antiparticles anti-Xi-minus and anti-Xi-zero (1962), experimentally validated the predictions of the Marcus theory (1960-1963), were the first to apply high-speed computers to realistic studies of problems such as defects caused by radiation damage (1959). BNL was first to apply neutron activation analysis to determine an object's origin, age, and its authenticity (1958). Research in hot atom chemistry laid the groundwork for future development of radiotracers used in studies of the brain (1954). In 1957 researchers received a Nobel prize for work in parity isolation. In 1952, scientists confirmed the theory of associated production of strange particles.

Issue Oriented Science: In 2000, BNL researchers devised a way to combine chemical treatment with "pollutant-busting" bacteria to remove cadmium from contaminated soil, found chemical changes in the brain that may underlie the cognitive deterioration associated with aging, and developed a new cement formulation for geothermal applications. BNL also developed a "quiet Jackhammer" (1999), determined that therapeutic doses of Ritalin are safe for children and that an epilepsy drug might offer an effective treatment modality for cocaine abuse (1998-99). BNL researchers determined that dopamine receptors and transporters in the human brain decline in tandem with normal aging (1998), developed a process to convert asbestos to a non-hazardous form (1997), imaged binding sites of nicotine in the human brain in 1996, and developed a graphical analysis system for kinetic analysis of reversibly binding radiotracers (1990); demonstrated that Ultraviolet A as well as Ultraviolet B can cause melanoma (1993); and conceived, designed and developed flat panel display. BNL was first to study chiral drug cocaine in living brain and map the binding sites (1989), first to measure brain metabolism in Alzheimer's patients (1983), and first to synthesize Fluorine-18 fluorodeoxyglucose (1979), the major PET radiotracer for research on the brain, and for diagnosis of heart disease and cancer. In 1971 BNL established the Protein Data Bank, a global repository for information about the structure of biomolecules. Earlier scientiests invented MagLev (1968), developed L-dopa treatment for Parkinson's disease (1965), developed Thallium radiopharmeceutical stress test (1965), synthesized human insulin (1964); and developed Technetium-99m radiopharmaeceutical for medical imaging (1960), which is used 36,000 times each day.

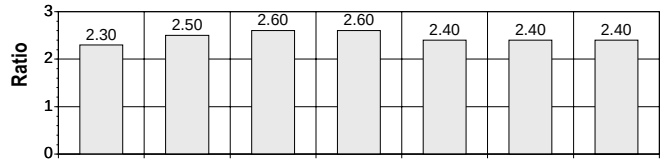
Brookhaven National Laboratory

Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

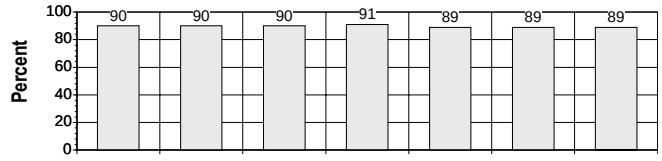
Category/Mission	*Partner*	*Description*
		Brookhaven National Laboratory engages in many partnerships and collaborations with other Departmental Labs, other Federal Agencies, universities, industry and international institutions. Most of these are a direct result of the Laboratory's lead role in support of the Science and Technology mission and the number of unique user facilities available for research. Each year more than 4000 visiting scientists use the Laboratory's facilities and work with the staff.
Science & Technology	Multinational Collaboration	RHIC detector development and experimental program (6 DOE Labs, 36 US Universities, 47 International Institutions). See http://www.rhic.bnl.gov
	FNAL, LBNL, CERN	Large Hadron Collider, Muon Collider
	ORNL, LBNL, ANL, LANL	Spallation Neutron Source
	Multinational Collaborations	Experimental program at the AGS including muon g-2 measurement, search for short lived dibaryon, exotic mesons, and novel forms of matter, very rare K(+) decays, spallation neutron targets. (52 US Universities, 44 International Institutes, 12 DOE Labs). See http://.www.rhichome.bnl.gov/AGS/
	NASA	Booster Applications Facility designed to study effects of radiation that may be encountered in deep space travel.
	DOE, Other Federal Agencies, Universities, Industry, International Institutions	Experimental programs at the NSLS including: medium energy physics, structural biology, structural determination of metal, surfaces, films and other complex materials, studies of catalysts and polymeric materials, semiconductors and alloys. (2500 users from 350 institutions/agencies). See http://www.nsls.bnl.gov
	Rockefeller University, Einstein College of Medicine	Research and development in functional and structural genomics/proteomics.
	5 Universities and 3 Federal agencies	Bio-medical research such as imaging studies, research in neuroscience, development of positron emitters, crystallography at the NSLS, operation of the STEM, protein structure and function, DNA damage and repair
	3 industries	Neutron activation for clinical research in AIDS, anorexia and obesity; development of immunological reagents for analysis of DNA damage response; radioisotope production for PET.
Energy Resources	10 U.S. Industries	Microaccelerator auto crash sensors, thin film batteries, development of corrosion inhibitors, catalytic production of organic chemicals.
	NRC	Technical assistance, regulatory research, operation of high temperature combustion facility, studies of age related mechanisms on cable aging and degradation.
Environmental Quality	PNNL	Safety of Soviet reactors
	University of Minnesota	Design, engineering and construction of FACE facility.
	EPA, NASA	Remediation of NY Harbor (EPA). Aerosol microphysics (NASA).
National Security	Department of State, FAA	Support to International Atomic Energy Agency in nuclear safeguards and safety of Soviet Reactors (Dept. State). Aircraft Reliability (FAA)

Performance Metrics (Normalized Data)

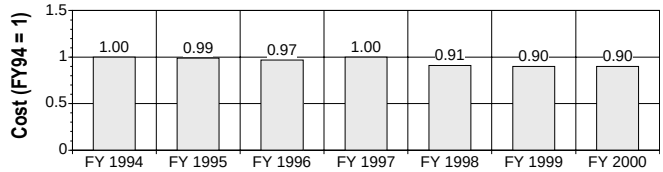
Research-to-Support



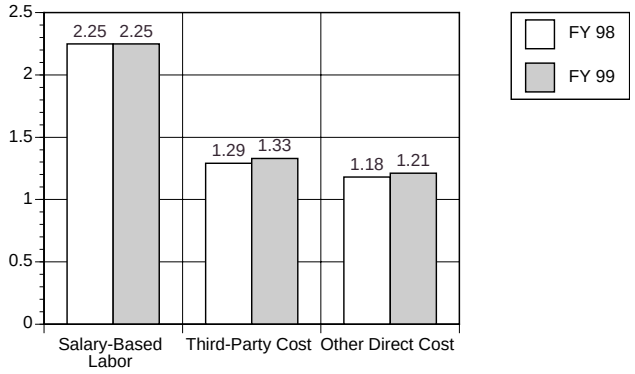
Percent of Technical Labor on Research



Average Cost per Research FTE



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Idaho National Engineering and Environmental Laboratory

Laboratory Information

Location: Idaho Falls, Idaho
Number of Full-Time Equivalent Employees: 1,445 (laboratory only)
Scientific and Technical Degrees: 1,016 (laboratory only)
Contractor: Bechtel BWXT Idaho, LLC (BBWI)
Accountable Program Office: Environmental Management
Field Office: Idaho Operations Office
Web Site: http://www.inel.gov

Funding Sources

Science: $6.2 million
Nuclear Energy: $59.7 million
Energy Efficiency and Renewable Energy: $6.0 million
Environmental Management: $389.8 million
National Security and Nonproliferation: $5.4 million
Fossil Energy: $3.2 million
Other DOE: $28.6 million
Non-DOE: $95.3 million

Total Funding: $594.2 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds. Naval Reactor funds ($51m) were tracked under NE.

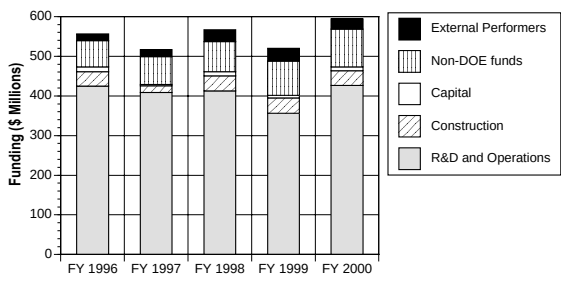
Description

The INEEL was established in 1949 as the National Reactor Testing Station and for many years was the site of the largest concentration of nuclear reactors in the world (fifty-two). During the 1970s, the laboratory's mission broadened into other areas, such as biotechnology, energy and materials research, and conservation and renewable energy. At the end of the Cold War, waste treatment and environmental remediation of previously contaminated sites became a priority. Today, the INEEL is a science-based, applied engineering national R&D laboratory dedicated to meeting the nation's environmental quality, energy resources, national security, and science and technology needs. Of its 1,445 employees, 220 are Ph.D.s, 406 hold masters degrees, and 526 hold bachelor degrees. The Idaho Laboratory is EM's designated national laboratory with a leading role in technology and systems for environmental stewardship, nuclear materials disposition, subsurface science, fate and transport research, complexwide requirements integration, and the commercialization of environmentally derived technologies. The laboratory provides energy solutions through a R&D portfolio including nuclear, fossil and renewable energy sources, and energy efficiency improvement. It is also the lead laboratory in geothermal and hydropower research and has a role in providing solutions to national security challenges.

Distinctive Competencies and Major Facilities

In support of DOE missions over the years, the INEEL has developed interrelated core competencies that distinguish it from other laboratories, uniquely positioning the INEEL for future contributions to national problems, particularly those involving environmental stewardship. The core competencies are: (1) Processing and Managing Radioactive and Hazardous Materials, (2) Developing, Modeling, Testing, Demonstrating, and Validating Engineered Systems and Processes, (3) Science Capabilities in Subsurface Geosciences and Geochemistry, and (4) Nuclear Reactor Design, Reactor Demonstration, and Reactor Safety. The INEEL operates a wide diversity of nuclear facilities used to process and manage radioactive and hazardous materials in a safe and environmentally compliant manner. From its experience as a major processor of DOE and U.S. Navy spent nuclear fuels, the laboratory has expertise in processing, handling, using, transporting, storing, and disposing of radioactive and hazardous materials. These activities developed expertise in intelligent automation of remote systems, chemistry, radiochemistry, and radiochemical processing. The INEEL integrates its biological, chemical, and geoscience capabilities through its subsurface geoscience investigations. Subsurface geoscience directly supports DOE's accelerated cleanup and long-term stewardship needs. The INEEL understands nuclear reactor operations and safety and is recognized internationally for its expertise in nuclear energy. The INEEL consists of seven primary facility areas which include 536 buildings and over 1,000 support structures. INEEL's major R&D facilities include the IRC and ATR. The IRC is a nationally recognized, world-class research facility in both fundamental and applied R&D in science and engineering areas critical to national and DOE missions. At this facility, scientist and engineers explore a range of disciplines including materials science, biotechnology, chemistry, optics, robotics, nuclear science, and nondestructive evaluation. The ATR is the world's largest and most versatile test reactor, used for producing isotopes and for irradiating and testing advanced materials. This world renowned, one-of-a-kind reactor environment is utilized to test the effects of radiation on materials and fuels. Information that would normally require years to gather from normal reactor operations can be obtained in weeks or months using the ATR's high-neutron flux capability.

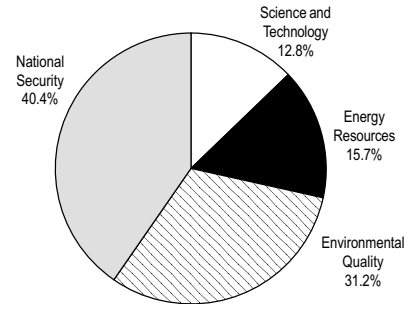
Funding by Activity



Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

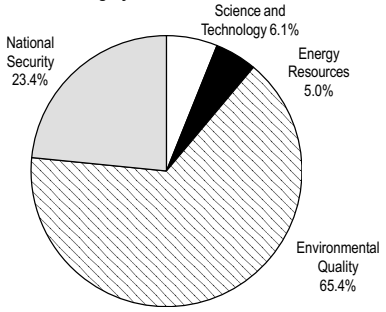
Funding by Mission Area

R&D Funding by Mission Area Total: $199.2 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment (based on FY 99 budget data).

Total Funding by Mission Area: $519.9 million



Note: Mission Footprint excludes remediation funds (based on FY 99 budget data).

Idaho National Engineering and Environmental Laboratory

Key Research and Development Activities

Environmental Quality. The INEEL, as DOE's lead EM laboratory, is unique in its approach toward and responsibility for achieving the DOE's Environmental Quality mission. The INEEL is the only consolidated national laboratory and operating site in the DOE complex. With responsibilities from science through engineering to operational deployment, the INEEL is uniquely positioned to make outstanding contributions. INEEL operations identify needs and opportunities, and INEEL scientists and engineers supply the technologies and science needed to fill the needs, opportunities, and gaps. The following key programs directly support this mission: Accelerated Site Technology Deployment, Complexwide EM Integration, EM Science Program, Environmental Restoration Program, Environmental Science Research Initiative, Environmental Systems Research and Analysis Program, High-Level Waste Program, Robotics and Intelligent Machines, Long-Term Environmental Stewardship, Mixed Waste Focus Area, National Analytical Management Program, National Spent Nuclear Fuel Program, Nuclear Materials Focus Area, Spent Nuclear Fuel Program, Subsurface Science Research, and Waste Management Program (includes Highly Enriched Uranium Program).

Energy Resources. From its inception as the nation's first laboratory devoted to civilian nuclear power through its development work in energy efficiency and renewable technologies, the INEEL has utilized its R&D capabilities to focus on solving national and international energy challenges. Application of these capabilities is driven by the objective of energy production and use with ecosystem sustainability. The INEEL's Advanced Nuclear Energy Program addresses nuclear energy science, technology development, engineering, and related disciplines of safety analysis and risk management. In 1999, DOE selected the INEEL and Argonne National Laboratory to serve as lead laboratories for nuclear reactor technology to assist DOE Office of Nuclear Energy in maximizing the value of the various reactor technology research activities conducted by DOE. The INEEL's Energy Efficiency and Natural Resources Program focuses on the science, technology development, deployment, and engineering for Fossil Energy, Energy Efficiency and Renewable Energy. The INEEL has recognized capabilities in multiple engineering and analysis disciplines and large-scale testing and in crosscutting energy and environmental technologies such as biotechnology; earth, geological, and chemical sciences; and geothermal and reservoir engineering. Examples include Vision 21 and other initiatives for work with hydrogen, related membrane technologies, industrial processes, distributed power systems, engineering related to U.S. energy infrastructure reliability, energy management technologies, alternate transportation fuels, and more efficient uses, including hybrid vehicles. The following key programs directly support this mission: Alternative Oil and Gas Drilling Technology Research, Bioenergy Research Program, Carbon Management and Sequestration Program, Coal Bioprocessing Research, Compressed Natural Gas/Liquefied Natural Gas Deployment/Demonstration, Energy Management Program, Energy System Reliability, Fusion Safety Program, Generation IV Nuclear Reactor, Geothermal Research Program, Global Climate Change Technologies/ CO2 Sequestration, Hydrogen Production, Industries of the Future, Energy Storage Technologies Laboratory, Hybrid Electric Vehicle Laboratory, Integrated Energy, Transportation, Environmental, and Economic Systems for Natural Parks and Gateway Communities, Methane Hydrates, Microbial Enhanced Oil Recovery Research, National Hydropower Program, Nuclear Energy Plant Optimization Program, Nuclear Energy Research, Advisory Committee and Subcommittee Membership and Support, Nuclear Energy Research Initiative, Partnership for a New Generation Vehicle, Power Plant Life Extension Program (INEEL and International), Site-Specific Technologies for Agriculture, and Vision 21 Hydrocarbon Processing Program.

National Security. The national security mission is driven by policies that reflect the increasingly complex global environment since the Cold War. Although the threat of global conflict is reduced, regional instabilities increase the potential for nuclear proliferation and terrorist deployment of weapons of mass destruction. Political and economic instabilities caused by the breakup of the Former Soviet Union have resulted in major concerns in accountability, control, and disposition of nuclear weapons and excess fissile materials and in potential employment of weapons scientists by rogue nations. A large fraction of the INEEL's evolving national security work originates as "Work for Others," with non-DOE U.S. Government organizations. This reflects well on specialized capabilities that exist at the INEEL for designing and building unique engineered systems. Examples include the Specific Manufacturing Capability, Mobile Munitions Assessment System, and projects supporting advanced military command and control systems. The following key programs directly support this mission: DOE DP Surety, Chemical Weapons Detection Technologies, Critical Infrastructure, Cybersecurity, Facility-Based Assessment System, Gamma Ray Spectrometry Center-Advanced Sensors, Idaho Accelerator Center Initiatives for Proliferation Prevention, International Center for Environmental Security (with Argonne National Laboratory), Ion Mobility Spectrometry Center—Treaty Verification Technologies Gamma Ray Spectrometry Center and Treaty Verification Technologies Center for Environmental Security (with Argonne National Laboratory), Mobile Munitions Assessment System, Nuclear Cities Initiative, Portable Isotopic Neutron Spectroscopy System, and Software Production Management Network.

Science and Technology. The INEEL's science and technology program is designed to extend the body of knowledge underlying current engineering practice in a variety of cross-cutting fields related to our support of the Department's missions. A centerpiece of the INEEL's R&D and Operations integration theme is the Subsurface Science Initiative, the major science initiative of the laboratory. This initiative has as its primary driver DOE's need to execute its EM cleanup and long-term stewardship missions at the INEEL, as well as the rest of the complex. The primary focus of this initiative is understanding how various chemicals move underground. The following key programs directly support this mission:Boron Neutron Capture Therapy, Chemical Sciences Program, Composite Materials, Elastic Plastic Fracture Mechanics Research, EM Science Program, Engineering Research Program, Environmental Systems Research and Analysis Program, Fractured Rock Science Team, Global Climate Change Project, Hydropower Program, INEEL Robotic and Intelligent Machines, Materials Science Program, Metallurgy Microstructural Research, Microstructural Research, Natural and Accelerated Bioremediation Research Projects, Scientific Computing Systems, Site-Specific Technologies for Agriculture, Subsurface Science Research, Surface Ionization Analysis Techniques, Teton-Yellowstone Project, and Thermal-Plasma Process Modeling.

Idaho National Engineering and Environmental Laboratory

Significant Accomplishments

Subsurface Science (1996–present): The INEEL has discovered extremophile microorganisms in the deep subsurface that catalyze the fixation of metals, including radionuclides, and mineralize organic pollutants. Other INEEL firsts: characterization of microbes that produce methane hydrates from earth/ocean sources; new infrastructure technologies for liquefied natural gas transportation; new down-hole seismic array concept for oil and gas exploration; new plasma processes for maximizing conversion efficiency of methane gas to higher value products. Transport Phenomena in Geologic Porous Media: The advanced tensiometer developed at the INEEL as part of this project permits measurements of the movement of fluids beneath the surface where both air and water may be present—the vadose zone and the aquifer. The breakthrough design can take measurements at almost any depth while being left unattended for weeks. It can be used for continuous monitoring of irrigation, water recharge, hazardous waste sites, and may be used to predict surface slumps. This instrument was a 1997 R&D 100 award winner. Study of Natural Attenuation: The INEEL demonstrated the occurrence of natural attenuation of chloroethenes through application of newly derived techniques to evaluate attenuation rates and mechanisms active within geochemically distinct zones of a contaminant plume. The techniques demonstrate a previously unrecognized interaction between dispersion and degradation to provide a strong technical basis for regulatory review and acceptance. Subsurface Radiological Assay Instruments: Three different radiological assay instruments for measuring contamination in subsurface soil and groundwater were developed and demonstrated. These instruments allow higher sensitivity, in situ measurement of beta- and alpha-emitting contaminants in subsurface soil and groundwater. The three instruments are a cylindrical triple proportional counter for strontium-90, uranium-238, and gross beta activity; down-hole xenon proportional counter x-ray spectrometer for actinide isotopes; and a Frisch grid ionization chamber borehole assay instrument for alpha-emitters such as uranium-234, uranium-235, thorium-230, plutonium-238, and americium-241.

Nuclear Science and Technology (1995–present): The INEEL developed and continually updates RELAP, the state-of-the-art computer code for nuclear reactor safety analysis. As a leader in nuclear reactor thermal-hydraulics, the INEEL developed analytical modeling techniques for predicting the behavior of reactors under transient and accident conditions. The wide acceptance of RELAP as the world's standard is signified by the fact that 22 countries presently use the code. Fusion Safety Standards: As DOE Lead Laboratory for Fusion Safety, the INEEL led the U.S.-wide effort to produce fusion safety standards on behalf of the U.S. Fusion Safety Steering Committee. The resulting two standards, safety requirements and compliance guidance, are the only DOE fusion safety standards in existence. For the International Thermonuclear Experimental Reactor (ITER) program, the INEEL provided the task area leader for safety and standards on the U.S. Home Team and performed significant and pivotal research in issues related to ITER safety and fusion in general. Advanced Radiation Treatment Planning Software: The INEEL will soon release the Simulation Environment for Radiotherapy Applications (SERA) for sophisticated dosimetry assessment for all modalities of neutron radiotherapy. Synthesis of Decaborane: The INEEL has developed a new, lower risk process for chemical synthesis of boron-10 enriched decaborane, a key precursor to several advanced boron agents for neutron capture therapy treatment of brain cancer.

Nanostructured Materials for Environmental Applications (1995–present): This three-year research initiative has produced tailored nanostructured materials for a range of environmental applications, e.g., catalysts, catalyst carriers, membranes, and porous electrodes. This class of materials includes nanophase particulate materials (<100 nm diameter) and dense-to-porous ceramic deposits with nanophase structures (<100 nm pore size). Potential environmental applications include catalytic destruction of pollutants in dilute waste streams, advanced separation (molecular sieves), conversion of end-products back to useful starting materials (recycling), and more environmentally friendly methods of manufacturing catalysts. INEEL devised an improved method of producing nanostructured materials using a plasma synthesis scalable to high throughput production levels. It has been used to synthesize several metal oxide nanophase powders, e.g., sulfated zirconia powder with crystallite on the order of 10–20 nm in size. The powder has about 1 wt% sulfur incorporated into its structure and has been shown to exhibit catalytic activity consistent with its sulfur content and surface area. The powder size and phase content or crystal structure can be tailored; the crystal structure helps determine the catalytic activity. Other INEEL nanostructure laboratory directed research and development (LDRD) projects have produced advanced magnet materials and devitrified nanocomposite steel armor.

Biotechnology (1995–present): INEEL biotechnologists are decontaminating concrete structures by using microbes that naturally damage concrete. By putting the microbes on contaminated concrete and providing ideal growing conditions, the microbes produce acid and dissolve the surface concrete that also holds the contamination. The powder left over from the microbial digestion is removed, taking the contamination with it. Advantages are minimal disposable waste and human exposure. Bioprocessing of Gases: The INEEL has developed the capability to treat toxic gases and vapors using biofiltration. Biofiltration employs natural microbes in a compost bed to degrade the gas or vapor and is often a lower cost alternative to other more conventional technologies. The INEEL has received an R&D 100 Award for its role in developing and commercializing the Biocube, a biofilter for the degradation of hydrocarbon vapors. Advanced Nonaqueous Biocatalysis: INEEL biotechnology researchers opened the door to using enzymes as catalysts in nonaqueous processes, a subject of major interest to DOE through its "Chemical Vision 2020" agenda. Breakthrough work with the enzyme, methane mono-oxygenase (MMO), from the micro-organism, methylosinus trichosporium OB3b, maintains enzymatic activity in a nonaqueous solvent at a level comparable with that seen in an aqueous environment. Whereas most enzymes only act on a few compounds, MMO catalyzes the oxidation of over 300 compounds including alkanes, alkenes, and aromatics. For example, MMO provides the key oxidation step to break down toxic trichloroethylene (TCE), a contaminant found at DOE and other sites, into nontoxic compounds. The leaders of the physiology and genome enhancement tasks received the INEEL Corporate Contractor's top recognition, the Lockheed Martin's Nova Award, in FY 1998 and FY 1997, respectively.

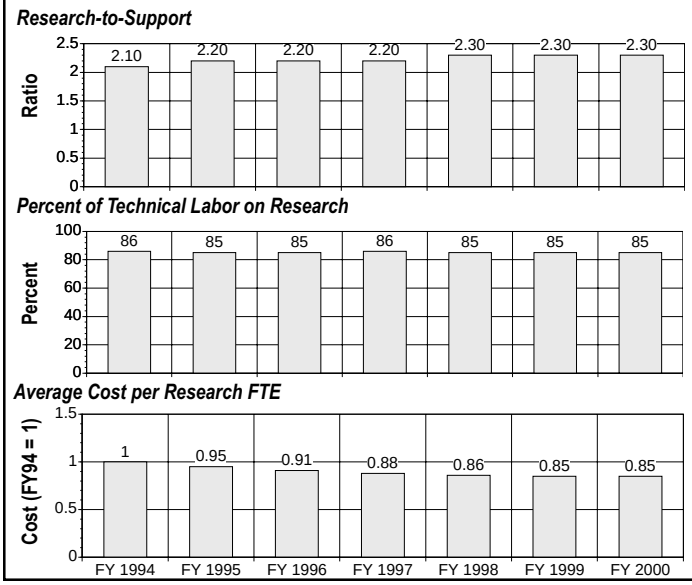
Chemical Weapons Assessment (1992–present): The INEEL develops integrated chemical weapon assessment systems for the Non-Stockpile Chemical Materiel Program of the U.S. Army. The INEEL has delivered the first integrated system (Mobile Munitions Assessment System) to the Army, that is currently being used in the field at Dugway Proving Ground. The second and third systems will be delivered in FY 1999 and FY 2000. Advanced sensors are constantly being developed to improve the systems.

Idaho National Engineering and Environmental Laboratory

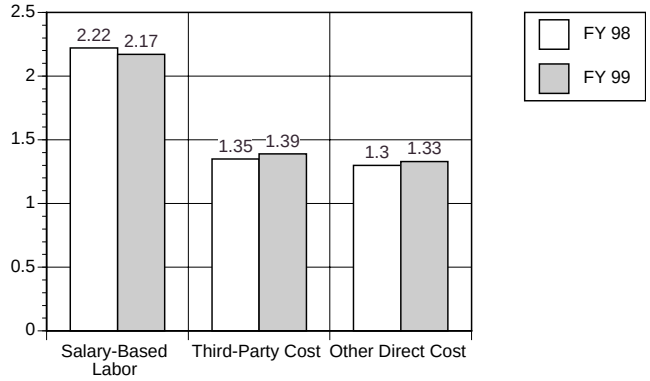
Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

Category/Mission	*Partner*	*Description*
Environmental Quality	University of Idaho, PNNL, EPA, AEA (UK)	Subsurface science and biogeotechnology research, natural attenuation of contaminants, characterization and remediation of surface and subsurface
	Canberra Industries, Envirocare, LANL, SRS	Focus Area integration in the development of TRU waste assay, mixed waste treatment, and disposition of plutonium
	MIT, NRC, SRS, ANL, France, Japan, Russia	Technology for the development, recycle, safe storage, and regulation of spent nuclear fuel. International Criticality Evaluation Benchmark Program
	Fernald, Parsons, BNFL, TLG Services	Accelerated Site Technology Deployment and Large Scale Demonstration of advanced deactivation and decommissioning technologies
	State of Idaho, Yellowstone Park	Natural Resource Initative, environmental collaboration on energy, infrastructure, watershed management, aquatic habitat, and hazard mitigation
	Greece, Russia, Korean Nuclear Society	Water treatment technology, advanced seperation technologies, and waste form evaluation and materials research
	U of Arizona, Miss. St., Utah St., Washington St.	Agriculture sensors and information systems for productivity enhancement and reduced environmental impact
Energy Resources	MIT	Research and development of advanced nuclear fuel cycles and power systems; development of improved regulatory system for DOE nuclear facilities
	UK, Japan, Korea, Taiwan	Irradiation testing of materials, advanced nuclear power and nuclear regulatory technical support technology development and transfer
	GM, Ford, Chrysler, SNL, ANL	Partnership for Next Generation Vehicle, electric/hybrid vehicle development, advanced battery research and development
	US Army COE, Bonneville Power, ORNL	Advanced hydropower turbine development; passive fish migration survival research
	GRI, Pacific Gas and Electric, BNL, ANL, et al	Research and development of technology for liquified natural gas fueled vehicles and supporting fueling infrastructure
Science and Technology	20 Universities	Ongoing University Research Consortium research on topics supporting DOE Missions for a total of $29M since 1995
	LBNL, LLNL, ORNL, PNNL, SNL, BNL, Ames	Seven projects in the DOE Center of Excellence for the Synthesis and Processing of Advanced Materials
	PETN-Netherlands	Boron Neutron Capture Therapy (BNCT) partnerships with European Union BNCT research programs for treatment of brain cancer
National Security	US Army	Development of next-generation chemical weapons assessment systems to be deployed by the Technical Escort Unit
	Idaho State University	Collaboration to establish the Idaho Accelerator Center for nuclear applications, includes nonproliferation applications
	LANL	Development of production process evaluation tools to support sound decisions for long-term, nuclear-stockpile stewardship
	Idaho Criminal Investigation Bureau	Partnership to establish the Northwest Testbed for drug enforcement technologies for the Office of National Drug Control Policy

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Lawrence Berkeley National Laboratory

Laboratory Information

Location: Berkeley, California
Number of Full-Time Equivalent Employees: 2,700
Scientific and Technical Degrees: 1,450
Contractor: University of California
Accountable Program Office: Science
Field Office: Oakland Operations Office
Web Site: http://www.lbl.gov

Funding Sources

Science: $243.2 million
Nuclear Energy:
Energy Efficiency and Renewable Energy: $24.9 million
Environmental Management: $8.7 million
National Security and Nonproliferation: $30.6 million
Fossil Energy: $4.7 million
Other DOE: $25.9 million
Non-DOE: $74.5 million

Total Funding: $412.5 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

Berkeley Lab is unique among the multiprogram laboratories with its close proximity to a major research university, the University of California at Berkeley. The Laboratory's principal role for DOE is fundamental science, including developing powerful experimental and computational systems for exploring properties of matter, deepening understanding of molecular interactions and synthesis, and gaining insights into biological molecules, cells, and tissues. Berkeley Lab is a major contributor of research on energy resources, including the earth's structure and energy reservoirs, fusion, combustion of fuels, and keys to efficient energy storage and use. The Laboratory is extensively involved in environmental research, including subsurface contaminant transport, bioremediation and indoor air quality. User facilities include the Advanced Light Source, National Energy Research Scientific Computing Center, National Center for Electron Microscopy, 88-Inch Cyclotron, Biomedical Isotope Facility and National Tritium Labeling Facility. Our multidisciplinary research environment and unique location serve to strengthen partnerships with industry, universities, and government laboratories. Partnerships include the Joint Genome Institute and programs in advanced accelerator and detector systems, x-ray lithography, high-speed networking and computer architectures, building and lighting systems, and science education. The Laboratory was established in 1931 by Ernest Lawrence, the "father" of team science.

Distinctive Competencies and Major Facilities

Major Facilities

Advanced Light Source: One of the world's brightest sources of ultraviolet light, soft x-rays and a powerful source of higher energy x-rays, serving as an excellent probe of the electronic properties of atoms, molecules, surfaces and condensed matter, and a powerful tool for determining the structure of macromolecules. 980 scientists are users on the ALS.

National Energy Research Scientific Computing Center and the Energy Sciences Network: Providing leading-edge computational resources, science and services; and national network for the scientific community. 2400 scientists are users at NERSC.

88-Inch Cyclotron: Produces the widest range of high-intensity and heavy ions in the US for nuclear science. Hosts over 200 users.

National Center for Electron Microscopy: One Angstrom, High-Voltage, Spin Polarized Low Energy, and Atomic Resolution Electron Microscopes. The facility hosts about 220 users annually.

National Tritium Labeling Facility: Prepares tritiated compounds as tracers for use in biosciences and health research.

Biomedical Isotope Facility: Provides short-lived tracers for high resolution Positron Emission Tomographies medical imaging.

Distinctive Competencies

Computational Science & Networking: Computational fluid dynamics and chemistry; applied mathematics; visualization; network research.

Particle and Photon Beams: Design of accelerators; induction linacs for fusion; beam dynamics; magnet design; x-ray optics.

Bioscience and Biotechnology: Structural biology and crystallography; genomics; cytogenetics; medical imaging.

Characterization, Synthesis, and Theory of Materials: Nanostructures; heterostructures; superconductors; alloys; magnetic materials.

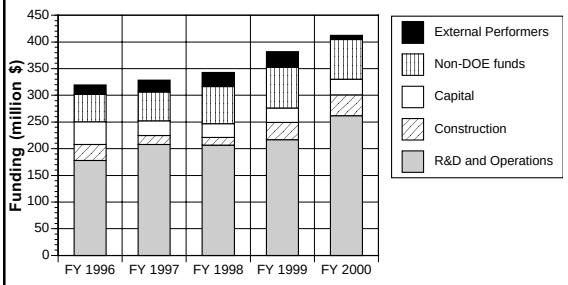
Advanced Technologies for Energy Supply and Energy Efficiency: Geo-resources; building technologies; electrochemistry; energy analysis.

Chemical Dynamics, Catalysis, & Surface Science: Reaction dynamics; photochemistry; surface structures; heterogeneous catalysis.

Advanced Detector Systems: Detectors for high-energy physics, nuclear science, and astrophysics; particle and photon detection.

Environmental Assessment & Remediation: Global environment; carbon management; indoor air; subsurface remediation; nuclear waste isolation; actinides.

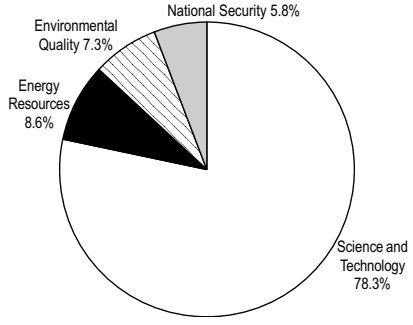
Funding by Activity



Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

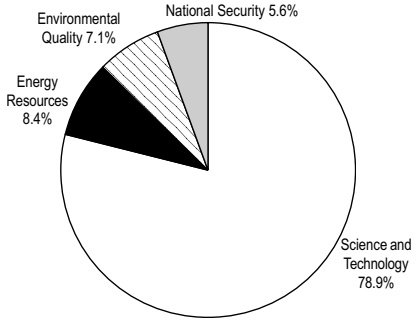
Funding by Mission Area

R&D Funding by Mission Area Total: $400.0 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $412.5 million



Note: Mission Footprint excludes remediation funds.

Lawrence Berkeley National Laboratory

Key Research and Development Activities

Science and Technology

Berkeley Lab's principal role as a fundamental science laboratory originated in supporting DOE missions in high energy and nuclear physics (particle physics), and continued with its pre-eminence in computation (first supercomputer available on the internet), the frontiers of physical chemistry and materials science and radiobiology, and the geoscience of complex environments. Berkeley Lab's science role continues to support DOE's mandate to apply the most powerful tools for advances in genomics, particle physics and astrophysics, nanomaterials, chemical dynamics, and heterogeneous subsurface environments.

– High throughput genome sequencing and macromolecular structure determination; functional genomics, molecular and cell biology; cellular differentiation, carcinogenesis and aging; subcellular structure; biochemical reaction networks, diagnostic imaging; boron neutron capture therapy

– Detector systems for high energy and nuclear physics and astrophysics; accelerators for physics research; theoretical particle and nuclear physics; superheavy element science; nuclear data evaluation

– High performance computing and computer science, and high-speed networks for scientific information systems, imaging and visualization; virtual laboratories; remote experimentation and databases

– Molecular design, synthesis and characterization of materials; low dimensional materials; materials physics and chemistry research, structure of materials; x-ray optics; advanced spectroscopy

– Fundamental chemistry and chemical physics and reaction dynamics; surface science and catalysis; reactivity of transient species; electron spectroscopy; actinide chemistry

– Ion beam science and technology development with medical and plasma applications

– Structure and dynamics of the Earth; geochemistry; geophysical imaging; isotope geochemistry

Energy Resources

Berkeley Lab supports DOE's energy role beginning with its pioneering work in the geosciences and geothermal energy; the applications of physical science to energy efficiency; the development of heavy ion drivers and high current ion beams for fusion energy; and international analysis of energy supply and demand. Berkeley Lab now brings powerful instrumentation and computational tools to advance these areas and to move ahead on DOE's missions for developing the next generation of batteries, building systems, fusion and fossil energy sources.

– Heavy ion drivers for inertial fusion energy including induction acceleration, beam manipulation, and beam combining technologies

– Buildings energy efficiency-windows and lighting systems including advanced thin films, superwindows, and novel illumination sources

– Electrochemical energy storage; photochemistry for high-performance rechargeable batteries and fuel cells

– Petroleum reservoir characterization and georesources through improved geophysical imaging and geologic transport models

– Electric reliability research through grid computer modeling and new technologies to improve grid performance

– Energy consumption and supply analysis in specific industries and technology areas, and in developing countries

Environmental Quality

Berkeley Lab has contributed to DOE's environmental quality mission through its discoveries on the importance of radon and indoor air quality, the potential impact of upper atmospheric emissions on atmospheric chemistry, and the mechanisms of contaminant transport through heterogeneous subsurface environments. Berkeley Lab now brings powerful computational and experimental tools for understanding risks at Yucca Mountain, the formation and control of contaminants from combustion and in flue gases, and the testing of global climate models.

– Subsurface characterization and the geologic isolation of high-level nuclear waste

– Contaminant transport, fate, and effects; physicochemical processes; repository performance

– Environmental biotechnology; environmental remediation technology

– Oceanic carbon sequestration; global emissions analysis; global climate change modeling

– Emissions and combustion control science and systems development

National Security

Berkeley Lab researchers perform unclassified research in support of nonproliferation and several analytical missions. This research encompasses:

– Detector development for portable lightweight gamma ray spectrometers

– Membrane-based calorimetric sensors for the detection of biological materials

– Laser fluorescence and nuclear detection capabilities for capillary electrophoresis

– Predictive tools to understand the dispersion of toxic agents in buildings

Lawrence Berkeley National Laboratory

Significant Accomplishments

Crystallographic Studies of Protein Structures: Determination of more than 250 protein structures with rapid protein crystallography at the Advanced Light Source, including the entire ribosome and many enzymes and drug design targets. 1997-2000

Genome Sequencing: Completion of the Draft Sequence of chromosomes 15, 16, and 19 with LLNL and LANL at the Joint Genome Institute, and the sequencing of Drosophila at Berkeley Lab. 1997-2000

Nanotechnology: Development and fabrication of nanotube circuits and single molecule transistors. 1996-2000

B-meson Physics: Conceptual foundations for the Asymmetric B Factory and the design and fabrication of the low energy B-Factory ring and the silicon vertex detector in BABAR. 1988-2000

Tubulin Structure: Electronic diffraction determination of the structure of Tubulin, a key protein of the cytoskeleton and the nucleoskeleton; X-ray studies revealing the structure of the cytoskeleton and the nucleoskeleton, and their importance in intracellular transport. 1996-1998

Accelerated Expansion of the Universe: Discovery and measurement of the most distant supernovas which give experimental evidence that the universe may expand forever. This research by the Supernova Cosmology Project was named "Breakthrough of the Year for 1998" by Science Magazine. 1995-1998

Extracellular Matrix and Breast Cancer: Development of evidence that the extracellular matrix is important to the phenotypic expression of breast cancer cells. This theory holds that there is a direct link between the development of breast cancer and a network of fibrous and globular proteins surrounding breast cells called the "extracellular matrix" or ECM. The ECM is crucial to the normal functioning of cells and loss of or damage to the ECM can lead to malignancy. Each new ECM experiment has yielded valuable knowledge about both normal and breast cancer cells. 1980-1998

Anisotropy of the Cosmic Background Radiation: The systematic observation (with COBE Satellite and BOOMERANG experiments) of ripples in the radiation afterglow of the primeval explosion that began the universe. These ripples are "hot" and "cold" regions in space, more than 1200 million light years across with temperature differences of a hundred-thousandth of a degree. They are the primordial seeds from which our present-day universe grew. 1975-1998

Billions of Dollars in Annual Energy Savings: Nationally significant energy savings through development of the most efficient window technology currently available, building energy analysis models now widely used, and transfer of advanced fluorescent lighting technology to industry. 1995-1998

Dominant Gene Link in Heart Disease: Identified first link between heart disease and a single dominant gene, showing that atherosclerosis results from a mix of behavioral, environmental and genetic factors. 1992-1998

First Directed Beams of Femtosecond X-rays: Strobe-like pulses of x-rays lasting only a few hundred millionths of a billionth of a second that can be used to study ultra-fast physical and chemical processes. 1990-1998

Transgeneic Mouse Models: A team of Berkeley Lab cell biologists and geneticists developed the first transgenic mouse that fully mimics all the symptoms of human sickle cell disease. 1996-1997

Subsurface Imaging: Systems for measuring and subsequent control of subsurface environmental processes including the highest resolution subsurface imaging, accurate prediction of subsurface transport, and cost effective solutions to containment of inorganic soils contamination. 1980-1997

Top Quark Detection: The discovery of the top quark, the last of six quarks predicted by the Standard Model of particle physics and one of the fundamental building blocks of matter, involved Berkeley Lab scientists and engineers in both of the project's experiments--the Collider Detector Facility (CDF) and the D-Zero. One of Berkeley Lab's most important contributions was the design of a sophisticated microchip for the Silicon Vertex Detector, an extremely high resolution instrument in the central CDF detector system. 1980-1996

Discovering Radon Exposure: Berkeley Lab was where the threat to American homes posed by radon was discovered. Exposure to radon gas in U.S. homes is thought to account for as many as 10,000 cases of lung cancer each year. 1985-1996

Catalytic Antibodies: Research that effectively expanded the genetic code from the 20 amino acids that nature provides to an exotic and potentially limitless array of synthetic amino acids won the Department of Energy's Lawrence Memorial Award. A Berkeley chemist invented a technique that made possible the incorporation of unnatural amino acids with novel physical and chemical properties into proteins by combining important features of catalytic antibodies and hybrid enzymes that he synthesized. 1985-1995

Predicting the Performance of Materials: Created one of the first-ever harder-than-diamond crystals and proved that computer models can play an effective role in the development of new materials. The new superhard crystal, a compound of carbon and nitrogen, was made from a recipe arrived at solely by theoretical calculations. These calculations showed that substituting carbon for silicon in the crystal structure of silicon-nitride would yield a super-hard carbon-nitride. 1980-1995

The Multicast Backbone (M-Bone): Developed by a team that included a Berkeley Lab computer scientist, M-Bone makes possible an electronic window through which users worldwide can not only see and talk to one another, but can work together on a shared "whiteboard." 1985-1995

"Stereotactic Radiosurgery": Pioneered the use of accelerated beams of ions as a scalpel on cancers and blood clots. 1970-1992

World's Largest Optical Telescopes: Design and prototype of the Keck telescopes. Each features a segmented mirror measuring 10 meters across that functions as a single optical element. 1980-1985

Cause of Dinosaur Extinction: Through neutron activation methods, extraterrestrial iridium was discovered in the layer of sediments at the Cretaceous Tertiary boundary (65 million years ago) in many regions on the globe, establishing the hypothesis that the mass extinction of the dinosaurs (and other species) was initiated by a meteor impact(s), a view now widely accepted among scientists. 1981

High Energy Physics and Nuclear Science: Discovery of the antiproton and the particle resonances. 1956-1965 Discovery of 15 elements, including the island of nuclear stability, and numerous isotopes of medical and technological value. 1935-1999

Development of Particle Accelerations: Earnest Lawrence invented the cyclotron; additional discoveries were the concept of phase stability and the synchrotron, the Alvarez Linear accelerator, and induction linear accelerators for fusion. 1931-2000

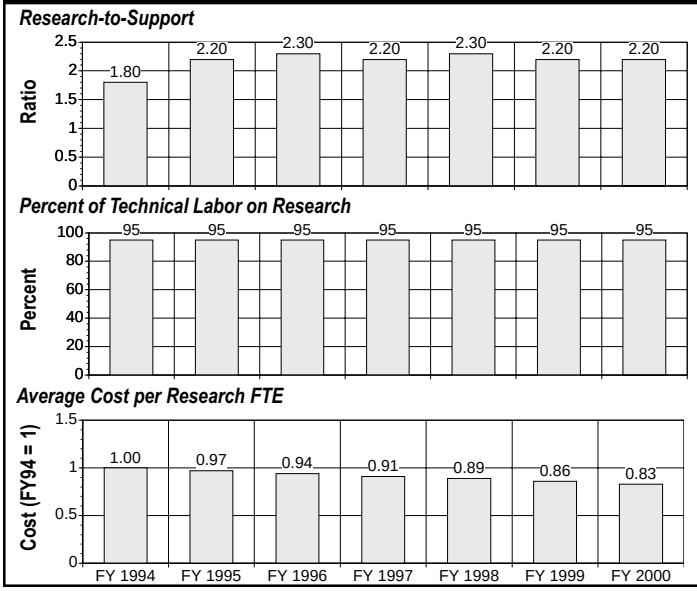
Lawrence Berkeley National Laboratory

Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

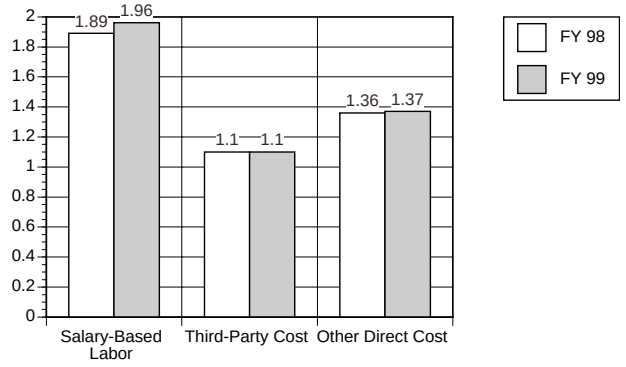
Research partnerships from academia, government and industry underlie many of the Berkeley Lab's programs. We have more than 4000 scientists from throughout the world who are users at our national facilities (remotely and on site), more than 1600 participating guests working at the Berkeley Lab, with over 1000 guests from academia demonstrating our close relations with universities. Berkeley Lab has more than 100 Collaborative Research and Development Agreements, many in the energy, biotechnology, semiconductor, and computer-related industries.

Category/Mission	*Partner*	*Description*
Science & Technology	US Berkeley	Sequencing the Drosophila genome
	UC San Francisco	Transgenic mouse model of Sickle Cell Anemia
	Many universities	ATLAS detector for Large Hadron Collider (international collaboration)
	Many universities	BABAR detector system for B-meson decay (international collaboration)
	Many universities	Solenoidal detector for the Relativistic Heavy Ion Collider (RHIC) (international)
	National Cancer Institute/NIH	Chemical carcinogens; human mammary cell studies; progesterone receptors
	LLNL, LANL	Joint Genome Institute
	Fermilab	Silicon vertex detector upgrades for D-Zero and CDF experiments
	ORNL, BNL, LANL, ANL	Spallation Neutron Source
	Chiron	High throughput assay for screening novel anti-cancer compounds
	Amgen, Inc.	Structure of the erythropoietin receptor
	Intel and IBM	X-ray photoemission microscopes at the Advanced Light Source
	CERN	NA-30 detector, magnets, ATLAS for Large Hadron Collider in Europe
	Ames	Heat capacity research, quasicrystals
	ORNL, ANL	DOE 2000 Collaboratory, interactive virtual labs
	Capintec, Inc.	Medical imaging scintillation camera
	Praxaire	Ionically conductive membranes for oxygen separation
Energy Resources	Several universities	Inertial fusion energy research
	U.S. AID	Energy efficiency in foreign countries
	Ford, Commings Engine	Diesel Collaboratory - Computation partnership
	State of California	Advanced building technology, electric reliability
	Scripps Institution of Oceanography	Subsurface imaging of salt domes with marine magnetotellurics
	Many companies	Crosshole and surface to borehole electromagnetic sensing
	Catalytica, Inc.	Catalyst optimization for heavy petroleum
	Several utilities	High performance energy efficient lamps
Environmental Quality	U.S. EPA	Volatile organic emissions research, HVAC analysis, cool roofs and efficient lighting
	PNNL	Environmental microbiology studies
	State of California	Sacramento River delta environmental quality improvement
	TRW Environmental	Yucca Mountain characterization studies
	Several universities	Bioremediation, Education, Science and Technology (BEST)
National Security	Battelle	Detection of bacteria in the environment
	DOD/Advanced Research	Terrain image navigation database

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Lawrence Livermore National Laboratory

Laboratory Information

Location: Livermore, California
Number of Full-Time Equivalent Employees: 7,300
Scientific and Technical Degrees: 1,200 PhD.'s; 1,600 Bachelor's/Master's
Contractor: University of California
Accountable Program Office: Defense Programs
Field Office: Oakland Operations Office
Web Site: http://www.llnl.gov

Funding Sources

Science: $60.8 million
Nuclear Energy: $0.2 million
Energy Efficiency and Renewable Energy: $7.3 million
Environmental Management: $49.8 million
National Security and Nonproliferation: $967.1 million
Fossil Energy: $2.0 million
Other DOE: $183.2 million
Non-DOE: $87.6 million

Total Funding: $1,358.00 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

Lawrence Livermore National Laboratory is a national security laboratory with responsibility for ensuring that the nation's nuclear weapons remain safe, secure, and reliable. Livermore also has a primary role in the Department's mission in the prevention of the spread and use of nuclear weapons, as well as other weapons of mass destruction. Established in 1952 to augment the nation's nuclear weapons design capability, Livermore made major advances in nuclear weapons safety and performance throughout the Cold War. To address national security needs, the Laboratory has pioneered the application of technologies ranging from high-performance computers to advanced lasers, and it has gained multiprogram responsibilities that draw on Livermore's multidisciplinary expertise. Today, the Laboratory's special capabilities, required for stockpile stewardship and nonproliferation activities, enable Livermore to meet enduring national needs in conventional defense, energy, environment, biosciences, and basic science. Research and development programs in these areas enhance the competencies needed to pursue the Laboratory's national security mission. Livermore serves as a resource to U.S. government and as a partner with industry and academia.

Distinctive Competencies and Major Facilities

High-Energy-Density Physics and Nuclear Science and Technology: Broad expertise in nuclear weapons, fission energy, and fusion programs, with exceptional capabilities for investigating the properties of matter at extreme conditions. Facilities: National Ignition Facility (NIF) (under construction), ultrabright/ultrashort-pulse lasers, two-stage gas gun, the Plutonium Facility, and the Flash X-Ray/Contained Firing Facility.

Advanced Lasers & Electro-Optics: Preeminence in laser science and technology, supporting stockpile stewardship, nonproliferation and defense needs, and many other laser and electro-optics non-military applications with NIF (under construction), ultrabright/ultrashort-pulse lasers, and the Microtechnology Center.

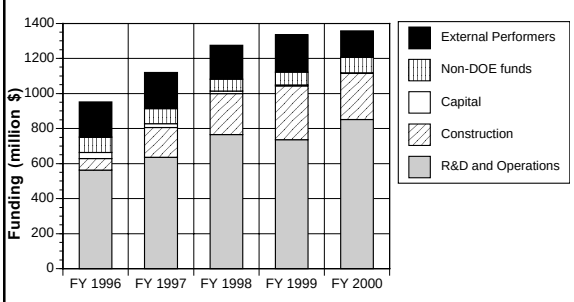
High-Performance Scientific Computing: Secure and Open Computing Facilities, including a 12-teraops supercomputer to support stockpile stewardship, offering the potential for major advances in climate modeling, environmental studies, materials science, bioscience, and many areas of physics.

Materials Science: Special capabilities for materials design, synthesis, processing, characterization and simulation for stockpile stewardship, energy and environmental research and development, and nuclear materials management with High Explosives Applications Facility, plutonium facility, Long-Term Corrosion Test Facility, and many other special facilities.

Multidisciplinary, Integrated Approach to Problem Solving: Activities range from fundamental science to production engineering of complex systems. A multidisciplinary-team approach provides the Laboratory with unique strengths for national security work and in such areas as biotechnology and environmental hazards characterization. Example facilities: Joint Genome Institute and the Laboratory's Human Genome Center, Forensic Science Center, and Center for Accelerator Mass Spectroscopy.

Computer Simulation of Complex Systems with Experimental Validation: For example, stockpile stewardship, magnetic fusion research and development (CORSICA simulation and spheromak), research and development support for a waste repository, and validated models for the National Atmospheric Release Advisory Center.

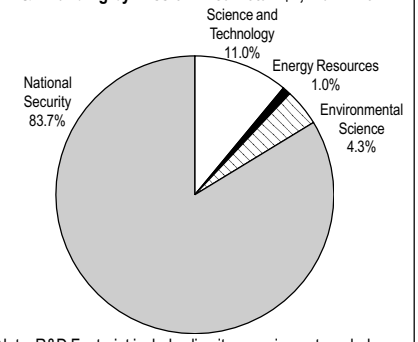
Funding by Activity



Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

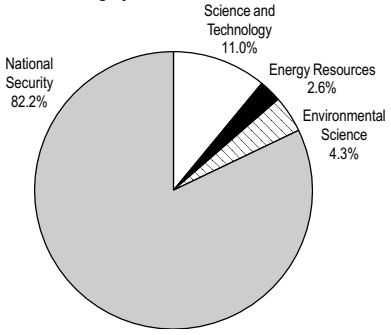
Funding by Mission Area

R&D Funding by Mission Area Total: $1,270 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $1,358 million



Note: Mission Footprint excludes remediation funds.

Lawrence Livermore National Laboratory

Key Research and Development Activities

National Security is the Laboratory's defining responsibility. As one of the Department's three national security laboratories that provide complementary capabilities, Livermore plays a prominent role in the Stockpile Stewardship Program. It is also addressing the increasingly serious problem of the proliferation of weapons of mass destruction (WMD). Building on the capabilities needed for these missions, the Laboratory develops advanced technologies for national security for other sponsors. It also pursues major projects in other areas where the Laboratory can make unique and valuable contributions, with a special focus on the enduring missions of the Department and on program areas that reinforce the Laboratory's national security work. Application of its special skills to selected efforts in ***Energy Resources, Environmental Quality,*** and ***Science*** leads to cross-fertilization of ideas. In turn, program diversity keeps the Laboratory vital and helps to sustain the multidisciplinary base needed for the Laboratory's national security mission.

National Security Mission

- Stockpile Stewardship: Maintenance of the nuclear weapons stockpile, assurance of weapon safety and reliability, and certification of performance in the absence of nuclear testing. The Laboratory is part of the Department's integrated program of Directed Stockpile Work, Campaigns, and Readiness in Technical Base and Facilities. Maintenance of the stockpile requires surveillance (including efforts to better predict aging phenomena), assessment (validated by simulation and experiments), refurbishment of stockpile components, and production of tritium.
  - — Stockpile Surveillance: special responsibilities for Livermore-designed weapons in the stockpile (W87 and W62 ICBM warheads, B83 bomb, and W84 cruise missile warhead) and efforts to develop the scientific base and monitoring capabilities to understand aging effects in all weapons.
  - — Stockpile Assessment: a comprehensive set of activities to provide the foundation for stockpile certification and refurbishment decisions, based on scientific and engineering demonstrations through an integrated program of computational simulation, fundamental scientific research, and experiments. Major investments at the Laboratory to markedly improve assessment capabilities include: Accelerated Strategic Computing Initiative supercomputers (Blue Pacific and Option White) to simulate the performance of an aging stockpile and conditions affecting weapon safety and the National Ignition Facility (a 192-beam laser to achieve fusion ignition and study the thermonuclear properties of weapons).
  - — Stockpile Refurbishment: including the W87 Life Extension Program and development (with production plants) of advanced manufacturing technologies (e.g., the Laser Cutting Workstation for Y-12) to improve quality and lower costs and environmental impact of refurbishment work.
  - — Integrated Program Management: Livermore is a key contributor to the development of the Stockpile Stewardship Program's detailed implementation plan (the Green Book) and to formal review processes for certification of weapon safety and reliability for annual certification.
- Countering WMD Proliferation and Use: The Laboratory's expertise in nuclear weapons, developed over time through its weapons program and its continuing stockpile responsibilities, is employed to counter the challenge of nuclear proliferation. Large investments in chemical and biological science support the development of technologies and expertise to stem the spread of chemical and biological weapons.
  - — Nonproliferation and Arms Control: analysis/technical support for arms control, nuclear safeguards, export control, and regional security.
  - — Monitoring Technologies: research and development of remote sensing, monitoring, and assessment technologies to detect WMD activities.
  - — International Assessments: assessment of the capabilities and motivations of foreign programs to develop or produce WMD.
- Technology Development for National Security: For other agencies to meet requirements and address emerging threats (see Partnerships).

Energy Resources Mission

The Laboratory pursues projects aimed at significant, large-scale innovations in energy production and usage. The Laboratory also serves as an effective national technical resource in the management of nuclear materials.

- — Nuclear Materials: modeling, engineering design, field testing, and experiments to ensure long-term containment of radionuclides; research & development in key aspects of the nuclear fuel cycle (including fission energy) to guide and support domestic and international programs.
- — Energy Alternatives and Carbon Management: technology development for fuel-efficiency and energy alternatives (e.g.,fuel cells and hydrogen-fuel capability), fossil fuel recovery, proliferation-resistant reactors, and carbon dioxide sequestering.

Environmental Quality Mission

The Laboratory's efforts are directed at demonstrating effective environmental remediation technologies, advancing the science base for environmental regulation, and accurately modeling regional weather and global climate conditions.

- — Global & Regional Climate Modeling: research on climate and atmospheric processes--model development, intercomparison, and validation.
- — National Atmospheric Release Advisory Center: near-real time modeling of released radioactive/toxic materials for emergency response.
- — Environmental Management: research, development, and demonstration of remediation technologies at Livermore and other sites.
- — Environmental Risk Reduction: modeling and new technologies to assess environmental consequences of toxic materials and manage risks.

Science Mission

Activities bolster the Laboratory's research strengths and contribute special expertise to solving important national problems. For example, bioscience research both contributes to the national security mission and leverages the Laboratory's physical science and engineering capabilities.

- — Bioscience & Biotechnology: multidisciplinary research and development including genomics, disease susceptibility identification and prevention, national security, computational biology, and healthcare technologies.
- — Fusion Energy Research: computations and experiments to advance the physics and technologies for magnetic and inertial confinement fusion.
- — Lasers and Electro-Optics: basic research, advanced manufacturing, and microfabrication (laser guide star, precision cutting, lithography).
- — Computer Science and Simulation: high-performance computing and information management, software technology, and systems integration.
- — Materials Science: research and development on design, simulation, synthesis, processing,and properties of existing and novel materials.
- — Astrophysics and Space Science: research on high-energy-density astrophysical processes and development of sensors for both space systems (e.g., multilayer optics) and astrophysics research (e.g., laser guide star adaptive optics).
- — Accelerator Technology: research and development supporting the Next Linear Collider—systems design and engineering, precision manufacturing.

Lawrence Livermore National Laboratory

Significant Accomplishments

Certification of the U.S. Nuclear Weapons Stockpile: Lawrence Livermore, Los Alamos, and Sandia national laboratories completed technical assessments in 1999 that provided the basis for the fourth annual certification of the stockpile. Subsequently, the secretaries of Energy and Defense certified to the President that the U.S. nuclear stockpile is safe and reliable and that no nuclear tests are needed.

Modern Nuclear Warheads for the Stockpile: In 1999, the Laboratory met the Air Force's Initial Operational Capability requirement for the refurbishment of the W87, extending the lifetime of the most modern ICBM warhead in the stockpile to beyond 2025. Since its founding, Livermore has pushed the state-of-the-art in nuclear weapons design and engineering, both increasing performance and adding safety features. Design advances at the Laboratory in the 1950s, for example, made possible compact thermonuclear weapons that could be submarine-launched. Livermore developed the first warheads for the Polaris SLBM and multiple-reentry-vehicle ICBMs.

The World's Most Advanced Scientific Computer Simulations: In 1999, a Laboratory team simulated in 3D the performance of the primary stage of a nuclear weapon using the world's most powerful computer. Livermore has been on the cutting-edge of scientific simulation from the arrival of the Univac in 1953 to the delivery in 2000 of the IBM ASCI Option White machine—capable of 12 trillion operations per second. The need to better simulate weapons performance has driven the development of increasingly capable high-performance computers by U.S. industry.

Pioneering Research and Record-Breaking Lasers: When completed, the National Ignition Facility (NIF) will be the world's most powerful laser and a cornerstone of the Stockpile Stewardship Program. The 192-beam laser will enable well-diagnosed experiments to examine fusion burn and study the thermonuclear properties of primaries and secondaries in nuclear weapons and validate related computer models. NIF will be the seventh (since 1975) in a sequence of successively larger lasers built at Livermore in pursuit of achieving inertial confinement fusion. Pioneering research in lasers at the Laboratory also led to the exploration of x-ray lasers in the 1980s and the development the world's first petawatt laser in 1997.

Advanced Experimental Diagnostics: Previously in nuclear tests, and now in nonnuclear experiments, the Laboratory has continually developed new diagnostic tools to enhance retrieval of as much high-quality data as possible, quickly and affordably. For example, in the 1980s Livermore led in the development of instrumentation such as streak cameras and x-ray spectrometers that used ultra-high bandwidth fiber-optic technologies.

Contributions to Arms Control and Nonproliferation: Since the late 1950s, Livermore has contributed to nuclear arms control by providing technical analysis and support and developing treaty monitoring capabilities. Also, in 1965, a formal program was established at Livermore to analyze for the U.S. intelligence community the Soviet nuclear threat and, thereafter, other international weapons-of-mass-destruction (WMD) threats. In addition to these assessments, the Laboratory's recent accomplishments to counter WMD proliferation include the development of sensors (e.g., fast, portable biological agent detectors and remote monitoring technologies), technologies for immobilizing plutonium, and tools to help U.S. policy makers and military planners (e.g., the Counterproliferation Analysis and Planning System). Livermore is also a principal participant in programs to improve the protection of nuclear materials in the former Soviet Union and reduce the proliferation of WMD expertise. The Laboratory is leading in efforts to convert to non-weapons applications work at the Avangard weapons plant (to production of medical equipment) and the Snezhinsk Open Computing Center.

Innovative Fusion Energy Research: Through experimental and computational efforts, Livermore researchers are advancing fusion energy science with the goal of eventually harnessing fusion as a peaceful source of energy. From the first year of its existence, Livermore has pursued innovative concepts to magnetically confine energetic plasmas (magnetic mirrors, tokamaks and other alternatives) and has led the pursuit of inertial confinement fusion. Fusion ignition and burn is the goal of the National Ignition Facility, which is now under construction.

Human Genome Sequencing: In 2000, the Joint Genome Institute (JGI) completed a working draft of the DNA sequence for human chromosomes 5, 16, and 19. The JGI, which merges the production sequencing efforts of Livermore, Los Alamos, and Berkeley national laboratories, is DOE's contribution to the Human Genome Project. The Project effectively began with DOE's Human Genome Initiative in 1987 and soon grew to include the National Institutes of Health as a partner in coordinating the effort in the U.S.

Improved Environmental Modeling: Home to the National Atmospheric Release Advisory Center, Livermore provides information for emergency response in the event of atmospheric releases—from the Chernobyl event to the Mount Pinatubo explosion in 1991, Gulf war oil well fires, and forest fires in 2000. Building on expertise that began with the modeling of nuclear fallout and test containment, Livermore is also contributing to international efforts to understand climate change by developing coupled ocean-atmosphere global climate models that run on its most powerful computers. In addition, the Laboratory is working to address key challenges in the Yucca Mountain program to dispose of high-level radioactive waste.

Discoveries in Astrophysics: The Laboratory's interests in astrophysics stem from expertise in high-energy-density physics and capabilities to develop advanced instrumentation. In the 1990s Livermore researchers discovered Massive Compact Halo Objects (MACHOs) in the search for "missing mass" in the universe; developed the sensor suite for Clementine, which collected over 1.7 million images while orbiting the Moon; created metallic hydrogen in a laboratory; and developed laser guide star adaptive optics to improve images from terrestrial telescopes.

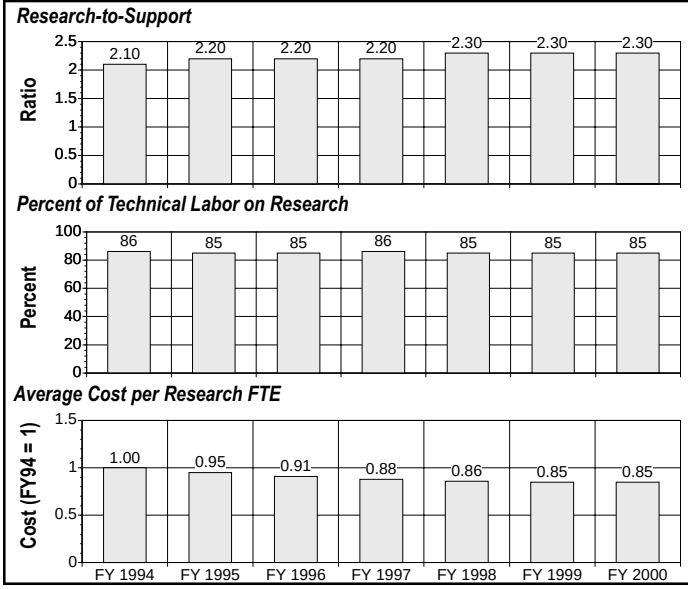
Award-Winning Science and Technology: The 1998 Nobel Prize for Physics was shared by Stanford Professor Robert Laughlin, an associate of the Laboratory for 17 years. The E. O. Lawrence Award has been presented to 22 Laboratory scientists and engineers for their exceptional contributions in the field of atomic energy. In addition, since 1978, Livermore researchers garnered 82 R&D 100 Awards.

Lawrence Livermore National Laboratory

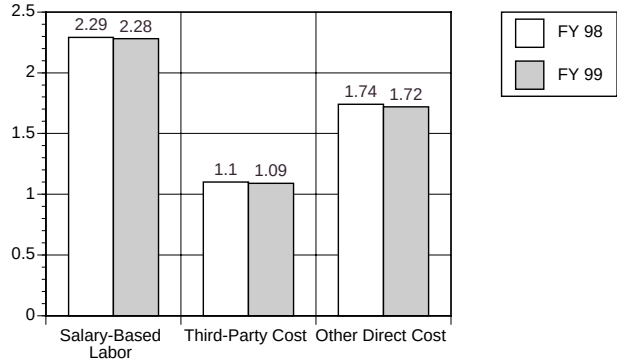
Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

Category/Mission	*Partner*	*Description*
National Security	Other DOE/DP sites	Stockpile stewardship, a DP complex-wide integrated program: multi-lab research efforts, production technology development with plants, experiments at NTS
– Other DOE	Stanford, Caltech, Utah, Illinois, Chicago, others	Academic Strategic Alliances Program (ASAP) centers (and others) supporting ASCI by accelerating advances in large-scale computational simulation
– Universities	U. of Rochester	Inertial confinement fusion program, including use of the Omega laser
–Industry	IBM and other firms; precision optics firms	Technology development and acquisition for stockpile stewardship: ASCI Blue Pacific, Option White, and PathForward; advanced technologies for NIF
– Other DOE	Other DOE labs and others	Nonproliferation activities: Immobilization of Plutonium; Joint Technical Operation Team for WMD incident response; development of advanced sensors and detectors
– International	Russian defense laboratories and others	With other DOE labs, Materials Protection, Control and Accounting projects at numerous sites in FSU and other U.S.-Russian "Lab-to-Lab" programs for conversion to non-weapons work
– Other Federal Agencies	Department of Defense	Advanced munitions & sensors; energetic materials; computer tools for design & analysis; counterproliferation support; combat simulation modeling; BMD-related technologies
– Other Federal Agencies	Various agencies	Analysis support & technology development (intelligence community); arms control analysis & support (State); forensic science & counterterrorism technologies (FBI)
Science & Technology	SLAC and LBNL (and others)	The SLAC B-factory and the Next Linear Collider, contributing design innovations, systems engineering, and precision manufacturing
– Other DOE	LBNL and LANL	Technology development and operation of the Joint Genome Institute for "production mode" sequencing of DNA and characterization
– Other DOE	National Institutes of Health	Bioscience research in DNA repair, reproductive biology, biodosimetry, and mutagenesis
– Other Federal Agencies	Washington U. and others	I.M.A.G.E. Consortium (the largest public collection of sequenced cDNA clones, at LLNL); collaborations to identify genes causing debilitating diseases
– Universities	University of California and others	Five LLNL-UC collaborative institutes; altogether about 1600 LLNL-university collaborations (faculty, research staff, and students)
– Universities	University of California and others	Center for Accelerator Mass Spectrometry: extremely sensitive measurement capability supporting diverse research efforts (20,000 samples/year)
– Industry	EUV Limited Liability Corporation	With LBNL and SNL, development of extreme-ultraviolet lithography for the manufacture of next-generation computer chips
– Industry	Various companies	Licences and CRADAs, e.g., in advanced lasers & electro-optics; medical technologies (glucose monitoring, stroke and radiation treatments); advanced batteries and fuel cells
– Industry		
Environmental Quality	Industry licensees	Dynamic-stripping cleanup technology at various DOE and Superfund sites (e.g., Savannah River; Visalia, California)
– Industry		
Energy Resources	Various companies	Technology development as part of DOE's Natural Gas and Oil Technology Partnership
– Industry		
– Other Federal Agencies	Nuclear Regulatory Commission	Development and certification of packages for radioactive materials and spent-fuel transportation packages

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Los Alamos National Laboratory

Laboratory Information

Location: Los Alamos, New Mexico
Number of Full-Time Equivalent Employees: 7,433
Scientific and Technical Degrees: 2,239
Contractor: University of California
Accountable Program Office: Defense Programs
Field Office: Albuquerque Operations Office
Web Site: http://www.lanl.gov

Funding Sources

Science: $77.4 million
Nuclear Energy: $15.9 million
Energy Efficiency and Renewable Energy: $25.3 million
Environmental Management: $48.7 million
National Security and Nonproliferation: $1,190.1 million
Fossil Energy: $6.6 million
Other DOE: $62.8 million
Non-DOE: $131.6 million

Total Funding: $1,558.4 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

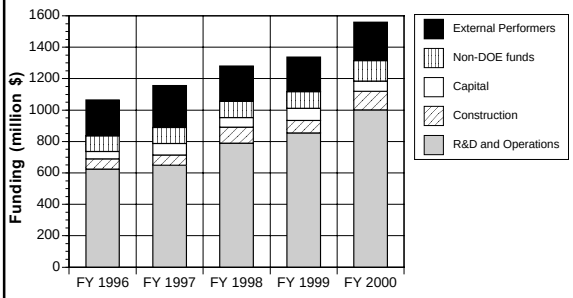
Description

Los Alamos National Laboratory is a national security laboratory whose mission to enhance global nuclear security involves stockpile stewardship, management and support; nuclear materials management; non-nuclear components fabrication; nonproliferation and counter proliferation; and environmental stewardship. Los Alamos was established in 1943 as the wartime Project Y of the Manhattan Engineering District with responsibility for developing the first nuclear weapon. During the Cold War era Los Alamos became a multi-discipline, multiprogram Laboratory applying capabilities from its original mission to national security and civilian needs. At Los Alamos computer modeling and simulation, and materials technology and component manufacture are playing an increasingly important role in stockpile stewardship as the stockpile is being reduced and nuclear testing is not an option for certifying stockpile reliability and safety. Los Alamos applies its expertise to key conventional defense and civilian issues that are synergistic with the central mission and capabilities. For example, the high-performance computing capability and related competencies address national problems as wide ranging as epidemics, global warming, traffic patterns, and forest fires.

Distinctive Competencies and Major Facilities

The Laboratory, distinguished by its ability to solve complex problems requiring integration of disciplines, highly specialized facilities, and unique operations expertise, defines its eight core competencies as follows: *Theory, Modeling, and High-Performance Computing*—combining fundamental theory and numerical solution methods with the power of high-performance computing; *Complex Experimentation and Measurements*—using multidisciplinary suites of diagnostics, unique measurement systems, and facilities designed for hazardous materials and processes; *Analysis and Assessment*—integrating basic theory and experimental data across disciplines into validated simulation models for unbiased assessment of complex systems; *Nuclear Weapons Science and Technology*—physics of nuclear weapons, large-scale calculations, science of weapons materials and properties, and experimental diagnostics; *Nuclear and Advanced Materials*—synthesis, processing, and application of nuclear and advanced materials; *Earth and Environmental Systems*—integrating earth, environmental, space, chemical, biological, physical, and engineering sciences; *Bioscience and Biotechnology*—integrating biology, cytology, spectroscopy, biochemistry, biophysics, and biomedical engineering; *Nuclear Science, Plasmas, and Beams*—integration of capabilities from the origin of a beam to its end-use. Major nuclear facilities are: **Plutonium Facility**—the Nation's full-service operating plutonium facility; **Weapons Engineering Tritium Facility**—state-of-the-art tritium research and development facility; **Critical Experiments Facility**—national resource for critical-assembly training and nuclear data measurements; **Chemistry and Metallurgy Research Facility**—facilities for plutonium metallurgy, advanced chemical diagnostics, and nuclear and radiochemistry. Major experimental facilities are: **Neutron Science Center**—national user-facility includes one of the world's most powerful proton linear accelerators and the proton storage ring; **Materials Science Laboratory**—provides experiments in high-temperature superconductivity, materials modification and analysis; **Dual-Axis Radiographic Hydrotest Facility**—premier three-dimensional hydrotest center, first axis commissioned November 1999; **National High Magnetic Field Laboratory**—unique facility that will produce 100-tesla magnetic fields for periods lasting up to 10 milliseconds (1000 times longer than anywhere else in the world). Major research facilities are: **Advanced Computing Laboratory**—for advances in high-performance computing; **Strategic Computing Complex**—30 TeraOp computing and simulation (construction on schedule for 2002 occupancy); **Health Research Laboratory**—contains the Center for Human Genome Studies, biological research, molecular biology, biochemistry, and genetics.

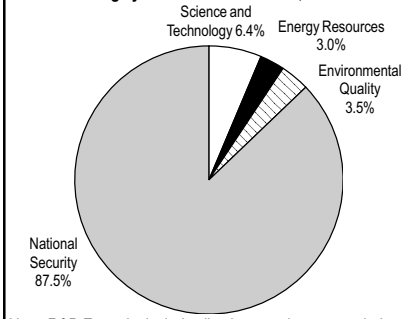
Funding by Activity



Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

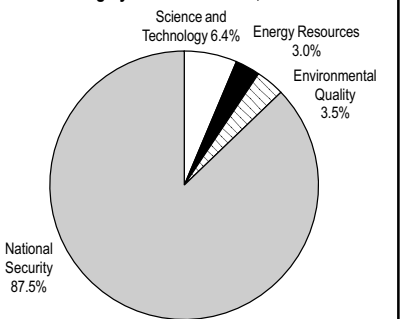
Funding by Mission Area

R&D Funding by Mission Area Total: $1,337.3 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment. (based on FY 99 data)

Total Funding by Mission Area: $1,337.3 million



Note: Mission Footprint excludes remediation funds. (based on FY 99 data)

Los Alamos National Laboratory

Key Research and Development Activities

National Security Mission

The Laboratory's national security mission provides support for and ensures confidence in the Nation's nuclear weapons stockpile. It is responsible for the safe and reliable condition of the weapons under its care. Each year, the Laboratory certifies the safety and reliability of the nuclear weapons stockpile to the U.S. Government. In the absence of nuclear testing, stockpile stewardship is a scientific and technical challenge requiring interdisciplinary approaches and the development of advanced computational modeling and simulation capabilities; enhanced surveillance techniques, tools, and instruments for complex experimentation, including hydrodynamic testing and high-energy-density physics experiments; innovative materials-science efforts; and establishment of new, efficient, economical, and environmentally compliant manufacturing methods. In addition, the Laboratory develops and applies the science and technology required to prevent, detect, and respond to proliferation of weapons of mass destruction. It works actively on many fronts to control nuclear proliferation and smuggling, such as developing new sensors and systems. It also is adapting advanced information and computing technologies to meet the challenge of nuclear, biological, and chemical weapons proliferation and terrorism. Major national security activities include the following:

— Certification of the national nuclear weapons stockpile to ensure the safety, reliability, and performance of the stockpile through activities such as Annual Certification and Dual Revalidation.

— Stockpile Stewardship Program, to support the enduring nuclear stockpile including surveillance, advanced surveillance and assessment; nonnuclear reconfiguration; materials support; fissile materials disposition; and enhanced experimentation in specialized facilities.

— Theory, modeling, and high performance computing in support of science-based stockpile stewardship, including development of predictive three-dimensional simulation and modeling codes and the Accelerated Strategic Computing Initiative (ASCI) to enable development and validation of the necessary computational simulation capability.

— Technology and expertise for securing and reducing nuclear weapons and materials and for preventing the proliferation of weapons of mass destruction. Includes domestic and international safeguards for nuclear materials and technology; joint programs with Russia for securing and for converting and disposing of fissile material; and technologies to verify arms control agreements.

— Detection and response technologies to counter proliferation or terrorism using nuclear, chemical, or biological weapons or threats against the US critical infrastructure (electrical grid, cyber, etc.), including training in unique facilities for national and international inspectors. Also includes programs for the Department of Defense, such as defeat of hard and deeply buried targets.

— Science and Math Education Program that gives students and teachers unique experiences by tying projects to Laboratory programs and capabilities.

Science and Technology Mission

Science and Technology programs at Los Alamos provide a strong foundation for the Nation's efforts in national security, energy, and the environment. The Laboratory engages in a wide spectrum of fundamental and strategic research such as materials science, neutron and accelerator science, high-performance computing, and biosciences. Activities include:

— Nuclear and High-Energy Physics such as search for neutrino oscillations, heavy ion physics, and particle physics research.

— Basic Energy Sciences such as development of advanced materials. Astrophysics and Fusion Energy including Magnetized Target Fusion.

— Computation, Modeling, and Simulation, e.g., modeling of combustion systems, and the DELPHI Project modeling the oceans, epidemics, and infrastructure.

— Biological and Environmental Research including the Human Genome Project, structural biology, epidemiology to develop the foundation for national health security and programs that counter threats from biological agents and infectious disease.

Environmental Quality Mission

Los Alamos environmental programs contribute to the preservation of regional and world sustainability. The Laboratory contributes to regional sustainability by addressing legacy contamination, by managing its waste streams in a responsible manner and by streamlining its operations. The Laboratory also contributes to solving complex environmental problems by applying its scientific expertise. Global environmental issues are addressed by linking environmental measurements, high-performance computing modeling, simulation, and assessment capabilities that provide prediction tools for decision-makers. These tools are used to evaluate the environmental consequences of major decisions such as damming a river or the effects of urban sprawl in arid regions. Major activities include the following:

— Environmental Restoration includes risk-based decontamination and decommissioning of surplus facilities.

— Waste Management, international control of actinides in the environment; Yucca Mountain site characterization.

— Pollution Prevention includes waste minimization, recycling, and process improvements.

— Technical Assessments and modeling for evaluating potential environmental impacts.

— Environmental Technology Development, ocean and climate modeling, modeling of wildfires, water resources, transportation system.

Energy Resources Mission

Activities in the energy portfolio focus on improving the Nation's energy efficiency, enhancing energy independence, mitigating greenhouse gas emissions and developing renewable energy sources. Major activities include:

— Energy and renewable energy research such as high temperature superconductivity, proton exchange membrane for fuel cells, and advanced computer programs for designing cleaner combustion systems, development of clean car technology.

— Energy technology such as simulation of transportation systems, air quality, nuclear waste management (e.g., characterizing the Yucca Mountain site), and medical isotope production.

— Advanced Chemistry for the development of better catalysts.

— Carbon Management to prevent the emission of carbon dioxide generated in the combustion of fossil fuels.

Los Alamos National Laboratory

Significant Accomplishments

Los Alamos and Sandia National Laboratories certified to the Department that no nuclear testing was needed to ensure the safety and reliability of the nuclear weapons stockpile. A comprehensive technical review supported the 1999 Annual Certification Report and the stockpile certification memorandum sent to the President.

Stockpile Stewardship Program (ongoing): A subcritical experiment was successfully fielded in March 2000 at the Nevada Test Site to investigate how various pit manufacturing proesses may affect the performance of a nuclear weapon. Neutron Resonance Spectrosocopy provided important data for developing high-explosive safety and performance models, e.g., measured the temperature and thickness of an explosively driven metal jet in flight, which provides validation data for the computer models. In March 2000, the Laboratory's lead Joint Test Assembly team successfully tested a new high-explosive radio telemetry diagnostic to monitor explosive-performance timing. The test was flown on a Lawrence Livermore reentry vehicle.

Accelerated Strategic Computing Initiative (ASCI): The 3-tera ops machine, Blue Mountain, was used in FY2000 to the execute a three-dimensional secondary-burn-code eight months ahead of schedule. Blue Mountain routinely executed calculations related to the safety and performance of the stockpile, vulnerability studies, and analysis of archived nuclear test data. The construction of the Strategic Computing Complex is ahead of schedule and under budget and Compaq was selected to provide a 30 tera-ops machine computer in 2004.

Proton Radiography and Hydrodynamic Testing: Los Alamos completed the first-small scale weapons hydrotest using proton radiography. Fourteen frames (images) were taken of the implosion which is also a record. The first axis of the Dual-Axis Radiographic HydroTest Facility (DARHT), the premier radiographic facility to study late-time hydrodynamic performance of weapon primaries, conducted its first hydronamic test in November 8, 1999. The second axis of DAHRT, which will provide multipulse-pulse x-ray capability to provide time sequenced, 3-D images is under construction (2002 completion) in partnership with Lawrence Livermore and Lawrence Berkeley.

Fabrication: In late 1999, W88 development pits, DEV4 and DEV5, were completed, signifying a major step toward the establishment of pit-manufacturing capability at Los Alamos. War reserves manufacturing and delivery of neutron tube targets, detonators, valve detonators, pit and milliwatt heat source surveillance, and beryllium parts is progressing well.

Nuclear Materials Management: The ARIES Demonstration Line completed an initial demonstration phase in 1999 to remove plutonium from the core of surplus nuclear weapons pits into a stable, unclassified, and assayed form suitable for long-term storage pending disposition as mixed oxide fuel and immobilization. In August 2000 the Laboratory successfully demonstrated Fissile Material Transparency Technology for monitoring nuclear material removed from Russian military programs. Los Alamos equipment is now operating in the former Soviet Union to monitor the blending of weapons-grade uranium with low-enrichment uranium to create reactor fuel in support of the U.S. Russian Highly Enriched Uranium purchase agreement.

Lab-to-Lab Program (ongoing): The Laboratory is working with the two nuclear weapons design laboratories in Russia, Arzamas-16 and Chelyabinsk-70, as well as at the Kurchatov Institute and nuclear production institutes. Enhanced materials protection, control, and accountability systems have been implemented at several of the Russian institutes. Los Alamos support of the Nuclear Cities Initiative resulted in the opening of Sarov computing center,the transition of the Avangard weapons production facility to open, civilian activity.

Environmental Restoration Project Acceleration (ongoing): Through the increased use of expedited cleanups and other engineering improvements, the Laboratory, in partnership with local subcontractors, continues to move up the date by which the 50-year legacy of contaminated buildings and soils are cleaned.

Computation, theory, modeling and simulation: Using a powerful supercomputer and extensive databases, researchers calculated that the ancestor of epidemic strains of the AIDS virus probably emerged around 1930—surprisingly long before the 1980s, when AIDS was first defined clinically in the United States.

Nuclear science and engineering: The recent discovery that a common soil microbe can bind plutonium contributes to our knowledge of biogeochemical processes that are important to the long-term performance of nuclear waste repositories.

Experimental physics: A novel prototype Ultra-Cold Neutron (UCN) Source, using the pulsed proton beam at LANSCE, set a world-record density of 100 UCN/cm3, opening exciting frontiers in fundamental physics.

Materials research: Experiments demonstrated that complex oxides possessing the fluorite crystal structure are inherently resistant to radiation damage, making them promising candidates for nuclear waste storage and other uses.

Sensor and detector development: Advanced Nondestructive Evaluation System (ANDE)— an R&D 100 Award winner in 2000— identifies chemical compounds in sealed containers at distances up to 15 feet and in less than 30 seconds.

Environmental science and technology: The terrible summer of western wildfires, beginning with the local Cerro Grande Fire, focused attention on Los Alamos' FIRETEC wildfire model, which incorporates realistic topography, vegetation, regional weather, and fire phenomenology. The model simulates fairly accurately a wide range of forest fires, even under the severest conditions of wind and heat—from urban, to complex terrain, to savannahs such as Cape Canaveral.

Nanochemistry: Research on ultrafast relaxation of electrons and holes in semiconductor quantum dots has led to a new understanding with significant potential for the use of semiconducting nanocrystals in optical devices or quantum dot lasers.

Bioscience: A new blood test helps identify workers who are sensitized to beryllium. Additionally, researchers discovered genetic markers that indicate who is at increased risk for Chronic Beryllium Disease. The Rapid Protein Folding Assay method makes correctly folded proteins glow green when exposed to ultraviolet light, providing a practical way to distinguish them from misfolded proteins—often linked to serious diseases.

Accelerator science and technology: A demonstration accelerator accelerated an unprecedented 100-mA, 6.7 MeV, continuous proton beam, laying key groundwork for numerous accelerator applications, such as tritium production, nuclear-waste transmutation, nuclear energy experiments, and medical isotope production.

Los Alamos National Laboratory

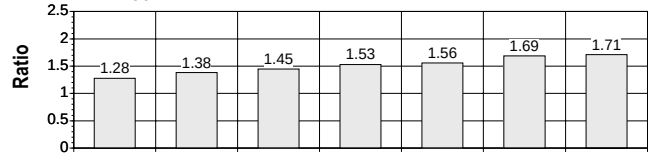
Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

The Laboratory carries out collaborative research with more than 230 universities world-wide. It has executed over 370 CRADAs, nearly $850M of company and Laboratory efforts over the lives of the projects, mostly in the areas of science and technology and energy. In addition, the Laboratory has 42 staffed user facilities and has executed more than 200 user-facility. High-performance computing and special facilities in all mission areas provide most partnering opportunities

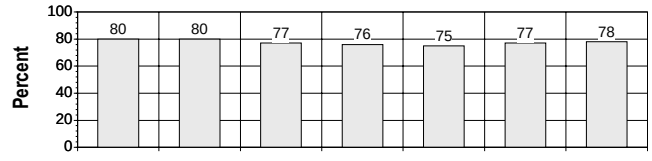
Category/Mission	*Partner*	*Description*
Science & Technology	Compaq, SGI/Cray, LLNL, and SNL	ASCI Tri-lab advanced computing initiative, High Performance Computing
	Russia, IAEA, SNL. LLNL, ORNL, Lockheed Martin, Motorola, Boeing	Nonproliferation
	Rensselaer Polytech. Inst., U of Illinois, Utah, Delaware, Illinois, Hawaii, and Washington St, UNM Colorado School of Mines (with NREL)	Explosives science and technology
	Cambridge (UK), Cal Tech, Oak RidgeY-12, Cornell, Motorola, P&G	Materials science and technology
	Xerox	Knowledge management
Energy Resources	DOD (Yuma), NOAA, DOI, Bandelier Nat Mon, USGS, NM State (Governor and Engineer), IT Corp	Water Quality and Environmental studies
	H Power, Plug Power, Motorola	Fuel Cells
	Rocky Flats, LLNL, SNL, LBL, WIPP, Pantex, NATO, Faraday, FETC	Clean-up, Waste Management and Transportation. (Inc Yucca Mountain)
Environmental Quality	EPA, NREL, PNNL,	Green Chemistry
	Pall Corporation	Filtration Technology
	GT Equipment	Super Critical CO2 Cleaning
Energy Resources/Environmental Quality	NCAR	Ocean and climate modeling
National Security	University of Chicago, Illinois, Stanford, and Caltech.	Supercomputing, Quantum Computing
	University of Wisconsin. & Minnesota, MIT, NSA USG	
	Raytheon	DoD Systems
Nuclear Weapons Program	Parametric Technology Corp.	Solid Model Design and Engineering Tools
	DOW	3-D Modeling of Polymer Structure/Property Relationships
	PPG	Polymer Sructure Degradationand Accelerated Aging
	Delphi Energy and Engine Management Systems	Reliability Modeling and Assessment
All mission areas	University of Arizona, State University of New York, Proctor & Gamble, Motorola	Non linear systems studies mathematical modeling, prediction, simulation
	ORNL, Fermilab, Brookhaven, CERN, Kamiokande All-Russian Sci Res Insti of Experimental Physics (VNIIF) State U. of New York	Physics and model verification
	Power Superconducting Devices, Boeing, ABB, Perilli, Oxford Inst, Argonne, ORNL, Brookhaven, SNL, American Superconductor, 3M, IGC	Superconductivity
	LLNL, LBNL	Joint Genome Institute for Sequencing DNA
	Department of Transportation, EPA, Cummings, Caterpillar, Cray Research, P&G, Raytheon, Motorola	Simulation and Modeling
	French Petroleum Institute	ACTI IFP
	University of Florida, NSF	National High Magnetic Field Laboratory

Performance Metrics (Normalized Data)

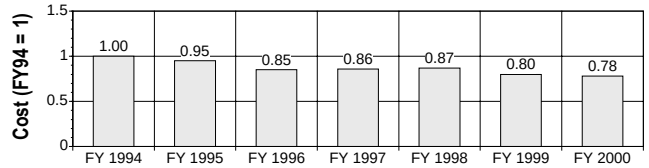
Research-to-Support



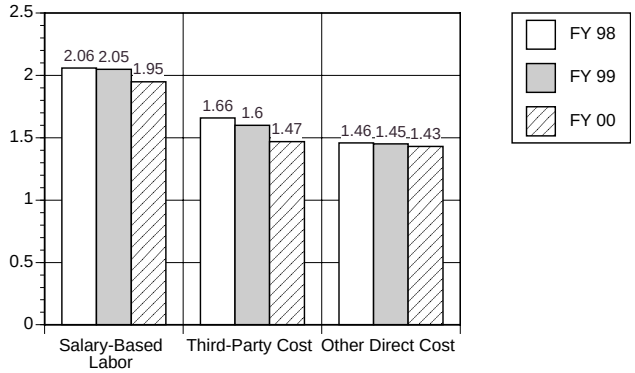
Percent of Technical Labor on Research



Average Cost per Research FTE



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Oak Ridge National Laboratory

Laboratory Information

Location: Oak Ridge, Tennessee
Number of Full-Time Equivalent Employees: 4,130
Scientific and Technical Degrees: 822 Ph.D's; 1,451 Bachelor's/Master's
Contractor: University of Tennessee-Battelle, LLC
Accountable Program Office: Science
Field Office: Oak Ridge Operations Office
Web Site: http://www.ornl.gov

Funding Sources

Science: $296.8 million
Nuclear Energy: $17.4 million
Energy Efficiency and Renewable Energy: $115.0 million
Environmental Management:
National Security and Nonproliferation: $32.7 million
Fossil Energy: $11.4 million
Other DOE: $57.8 million
Non-DOE: $89.4 million

Total Funding: $620.5 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds. NE includes sale of isotopes.

Description

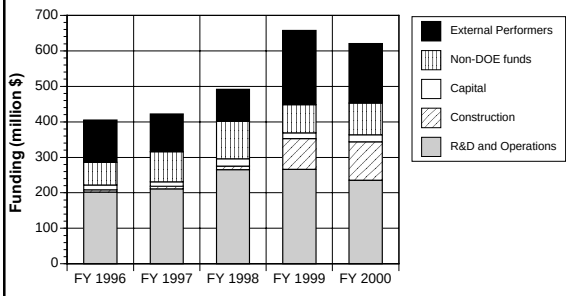
The Oak Ridge National Laboratory is a multiprogram science, technology, and energy laboratory established in 1943 as an element of the Manhattan Project. Capabilities developed to fulfill its wartime mission have evolved into distinctive strengths in materials science and engineering, neutron science and technology, energy production and end-use technologies, mammalian genetics, environmental science, and scientific computing. Oak Ridge draws on unique facilities in applying these strengths to critical questions about global energy and environmental issues. Neutrons from the High Flux Isotope Reactor support isotope production and materials research and development. The Spallation Neutron Source (under construction) will extend the nation's capabilities for determining the structure of physical and biological materials. Fundamental nuclear properties and astrophysics are explored with radioactive ion beams. Other research facilities support the integration of basic and applied research, leading to new tools and techniques for clean and efficient production and use of energy, better understanding of complex biological systems and the relationship between genetics and health, and increased ability to determine and mitigate the environmental effects of energy production and use.

Distinctive Competencies and Major Facilities

Distinctive competencies are distributed in six major areas: Advanced Materials Synthesis, Characterization, and Processing; Biological and Environmental Sciences and Technology; Computational Science and Advanced Computing; Energy Production and End-Use Technologies; Instrumentation and Measurement Science and Technology; and Neutron-Based Science and Technology. Major facilities include:

- **The High Flux Isotope Reactor,** among the world's most powerful research reactors, with unique capabilities for isotope production, neutron scattering research, materials irradiation, and neutron activation analysis; the associated Radiochemical Engineering Development Center offers facilities for producing transuranium actinide elements.
- **The Holifield Radioactive Ion Beam Facility,** enhancing the understanding of nuclear structure and nuclear astrophysics.
- One of the world's most powerful unclassified computing centers, with a peak computational power of 1.5 teraflops, massive storage, high-speed networks, and exceptional external connectivity.
- **The Mouse Genetics Research Facility**, combining extensive stocks of mutant mice and expertise in mouse genetics and mutagenesis, phenotype screening, and high-throughput analytical technologies to enhance the understanding of the development and functioning of biological systems.
- **Extensive materials research at the High Temperature Materials Laboratory** (collaborative research on advanced ceramics and alloys), the **Surface Modification and Characterization Research Center** (fundamental studies of ion-solid interactions and ion beam processing for advanced thin-film science and technology), and the microanalytical facilities available through the **Shared Research Equipment Program**.
- **The Oak Ridge National Environmental Research Park**, which contains specialized facilities for large-scale ecosystem research.
- **The Buildings Technology Center** for work on combined cooling, heating, and power and on thermal envelope systems and materials.
- **The Center for Structural Molecular Biology**, linking neutron science, biological mass spectroscopy, and high-performance computational tools.
- **The National Transportation Research Center,** providing access to unique facilities and capabilities through a public/private partnership.
- **The Spallation Neutron Source**, the world's most powerful facility for pulsed neutron scattering research (under construction).

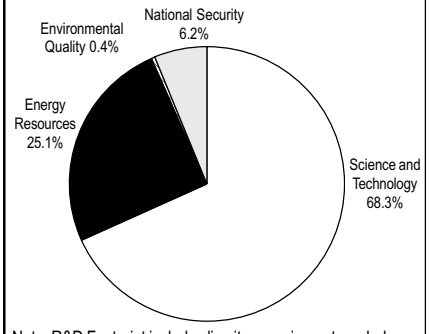
Funding by Activity



Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

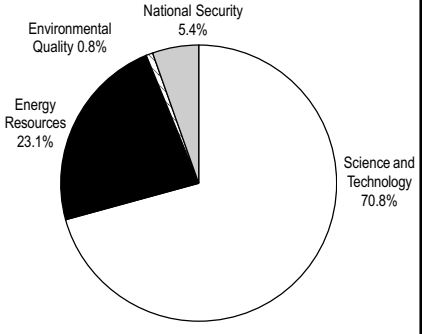
Funding by Mission Area

R&D Funding by Mission Area Total: $531.1 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $620.5 million



Note: Mission Footprint excludes remediation funds.

Oak Ridge National Laboratory

Key Research and Development Activities

Science Mission

The Laboratory's science programs deliver scientific advances and technical innovations that enable the Department to carry out its missions. Research and development activities span the following fields:

— Materials science and engineering, with emphasis on development of ceramics and composites, metals and alloys, carbon-based materials, surfaces and thin films, polymers, and high-temperature superconductors; nanoscale science and engineering; and new techniques for materials synthesis, processing, and characterization.

— Neutron science: neutron scattering, isotope production, and design and operation of accelerator-based and reactor-based neutron sources.

— Life sciences, with emphasis on functional genomics and proteomics, biotechnology, bioengineering, computational biology, and bioinformatics.

— High-performance computing: Computer and computational science, distributed computing, networking, and intelligent systems.

— Environmental sciences, spanning ecosystem research and global change science, environmental processes science and technology, microbial ecology and genomics, plant sciences and genomics, ecological management science and technology, renewable resources research and development, and environmental data systems.

— Separations and analytical chemistry, chemical sciences, and chemical engineering technology, with activities in separations science, hydrothermal solution chemistry and geochemistry, actinide science and radioactive materials characterization, isotope separations, computational chemistry and chemical engineering, integrated chemical and bioanalytical instrumentation, miniaturization of chemical reactions and separations, mass spectrometry, environmental monitoring and technology, materials chemistry, fundamental chemistry of energy production and use, and interface and surface science.

— Fusion science and technology, spanning plasma theory, magnetic confinement experiments, plasma heating/fueling, atomic physics, and materials development.

— Studies of the fundamental properties of matter at the atomic, nuclear, and subnuclear level: nuclear structure physics and nuclear astrophysics with radioactive ion beams; relativistic heavy-ion beam physics; and atomic, molecular, and optical physics.

— Instrumentation and measurement science and technology.

— Social sciences, providing support for planning and policy decisions related to major energy and environmental issues.

The Laboratory is engaged in major initiatives in neutron sciences, complex biological systems, terascale computing and simulation science, energy and environmental systems of the future, and advanced materials to enhance its ability to support the missions of the Department.

Energy Resources Mission

Energy programs span basic and applied research, technology development, technical assistance, and management of energy-related information. They link the physical, engineering, economic, and social sciences to provide not only new science and technology but also frameworks for improved performance in technology development and deployment, analyses of environmental externalities connected with energy production, and insights for planning and policy decisions related to major energy and environmental issues. Key focus areas are:

— Energy-efficient technologies for buildings, industrial, transportation, and utility end-use

— Biomass energy, with a focus on sustainable biomass feedstock and conversion technologies

— Distributed energy resources, emphasizing integrated systems and utility reliabiity

— Carbon sequestration research and development

— Fossil energy, emphasizing applied materials, fuel cells, and efficient turbine systems

— Nuclear technology and safety

Environmental Quality Mission

The Laboratory supports the cleanup of the Department's environmental legacy through the integration of capabilities in analytical chemistry, biochemical engineering, bioremediation, biotechnology, chemical separations, earth and ecological sciences, environmental chemistry and engineering, geological sciences, instrumentation and measurement science and technology, and robotics and intelligent machines. Key activities include:

— Environmental management science

— Environmental technology development

— Life cycle analysis and environmental risk assessment

National Security Mission

The Laboratory contributes to the Department's strategic goal of supporting nuclear security, promoting international nuclear safety, and reducing the global danger from weapons of mass destruction through activities in:

— Management and disposition of weapons-related nuclear material

— Promoting nonproliferation and international nuclear safety, with an emphasis on reducing the threat from chemical, biological, and nuclear agents

— Strategic computing for safe stockpile stewardship

Oak Ridge National Laboratory

Significant Accomplishments

Spallation Neutron Source (SNS): The SNS, a top-priority project for the Department of Energy, is under construction. A collaborative effort by six national laboratories, the SNS is an accelerator-based neutron scattering facility that will produce neutron beams 12 times as intense as those from existing pulsed sources. It will enable researchers to "see" the details of physical and biological materials, ranging from high-temperature superconductors to proteins. (2000)

Record-Setting Scientific Computing: The Laboratory hosts one of the world's most powerful unclassified computing centers, with a peak computational power of 1.5 trillion operations per second (teraflops). Its computational resources were used for a simulation of the behavior of magnetic materials that has been recognized with a 2000 Computerworld Smithsonian Award for being the first ever to run at a sustained speed of more than 1 teraflops, ushering in a new age of scientific problem solving. (2000)

Biomolecular Electronics: Researchers at the Laboratory have performed the first measurements of photovoltages generated by reaction centers extracted from the leaves of green plants, offering intriguing possibilities in molecular electronics and biotechnology. This work may lead to the development of new solar photovoltaic cells and other energy sources. (2000)

Vacuum Nanoelectronics: The discovery of a method for fabricating nanoscale electron emitters in place in microfabricated and nanofabricated electrode structures will allow the development of vacuum nanoelectric devices that operate at frequencies approaching 1 trillion hertz. (1999)

High-Temperature Superconductors: Superconducting tapes with high critical current density can be created using the Laboratory's RABiTS™ process, which combines low-cost textured metal substrates and thin-film superconductors and should lead to more efficient transformers, motors, and generators. This technology won an R&D 100 award and has been licensed to industry. A 30-m-long high-temperature superconducting cable developed in collaboration with industry is delivering power to an industrial customer. (1996–present)

Ecosystem Science: Through seven years of sustained precipitation manipulations at the Throughfall Displacement Experiment on the Oak Ridge Reservation, Laboratory researchers discovered that mature trees in eastern deciduous forests are more resistant to reduced precipitation than predicted by current models. The results are being used to develop more accurate models. (1993–present)

Software Development: Four software packages developed by the Laboratory and its partners have won R&D 100 awards. PVM (Parallel Virtual Machine), in use at hundreds of computing sites, permits a large, diverse collection of computers to work together as a single powerful computer. HPSS (High Performance Storage System) is the industry standard for managing very large data archives. ATLAS (Automatically Tuned Linear Algebra Software) is used for automatic generation and optimization of software. NetSolve is a client-server system for remote solution of scientific problems. (1993–1999)

High-Resolution Imaging: The Laboratory's MicroCAT system provides detailed images of soft tissue and bones in mice and other laboratory animals, giving researchers a new tool for studying genetic mutations. The MicroCAT rapidly generates three-dimensional images with 10 times the resolution of conventional tomography systems, and it is the first such system to scan live specimens. The MicroCAT, used at the Laboratory to study fat deposits in a genetically engineered obesity-prone mouse, is now commercially available. (1998)

Reducing the Nuclear Threat: A monitoring system developed for the Highly Enriched Uranium Transparency Program can monitor the flow of fissile material in process piping without penetrating the piping. The system is used to monitor "downblending," a process for producing reactor fuel that uses uranium from dismantled nuclear weapons. Two systems have been shipped to Russia. (1998)

Neutron Scattering: The Laboratory's pioneering work in neutron scattering, which began on the Graphite Reactor in the 1940s, was recognized in 1994 when the Nobel Prize in physics was awarded to Clifford Shull. Shull and his colleague, the late Ernest Wollan, developed a method for using patterns of scattered neutrons to determine the arrangement of ordinary and magnetic atoms in solid samples. Their efforts and those of Bertram Brockhouse, who shared the prize with Shull, gave rise to the field of neutron science. (1994)

Atomic Imaging: Using the Z-contrast imaging technique developed at the Laboratory and the world's highest-resolution scanning transmission electron microscope, researchers produced the first direct images of the structure and chemical identity of atoms at critical regions inside solids. The discovery of unexpected structures in semiconductors, ceramics, and superconductors has brought unique insights into the macroscopic properties of these materials, pointing the way to methods for improving a wide range of advanced materials. (1988–present)

Battery Development: Thin-film batteries developed at the Laboratory can be deposited directly onto integrated circuits (chips) or chip packages of any size or shape, and they can be recharged thousands of times. The small size and high energy density of these batteries are leading to improvements in products such as sensors, implantable defibrillators, and neural stimulators. (1987–present)

High-Temperature Materials Development: Work at the Laboratory has led to the development of two classes of materials—whisker-toughened ceramics and ductile intermetallic alloys—and to processes and products with significant economic impacts. Whisker-toughened ceramics are sold as cutting tools. The gelcasting process for making high-quality ceramic parts in complex shapes is used in manufacturing turbine rotors, thermal insulation for engine exhaust manifolds, and magnet rings for particle accelerators. The Exo-Melt process saves time and energy in manufacturing nickel aluminides (used for furnace trays, belts, and rollers) and iron aluminides (used for hot-gas filters and heating elements). A ceramic composite filter developed with the 3M Company is lighter, more reliable, and more efficient than conventional filters. (1981–present)

Record of Innovation: The Laboratory has won 107 R&D 100 awards, a total exceeded only by General Electric and NASA. The awards are presented annually by R&D Magazine for the year's 100 most significant technological innovations. (1963–present)

Cryobiology: Laboratory researchers pioneered the development of techniques for preserving life in a frozen state. A wide variety of cell types have been preserved. Cryopreservation of the embryos of fruit flies, a major experimental organism for genetics and developmental biology, was demonstrated at the Laboratory in 1990, leading to less expensive means of preserving genetically important mutations. (1962–present)

Genetics and Genomics: The field of mammalian genetics, studied at the Laboratory since 1948, was advanced by the 1979 identification of ethylnitrosourea (ENU) as a "supermutagen" and the development of effective ENU mutagenesis assays. Today's comprehensive program focuses the Laboratory's extensive resources in functional genomics and proteomics, structural biology, plant sciences, microbiology, computational biology and bioinformatics, and analytical technology on understanding complex biological systems. (1948–present)

Isotope Development and Production: The Laboratory has produced isotopes for medicine, research, and industry for more than 50 years. It is the principal supplier of several isotopes used in cancer treatment, nondestructive testing, and explosives detection. The Laboratory also contributes to nuclear medicine by developing methods for producing and processing radioisotopes for research and clinical use. Applications include cardiac imaging, bone pain palliation, and selective tumor destruction. (1946–present)

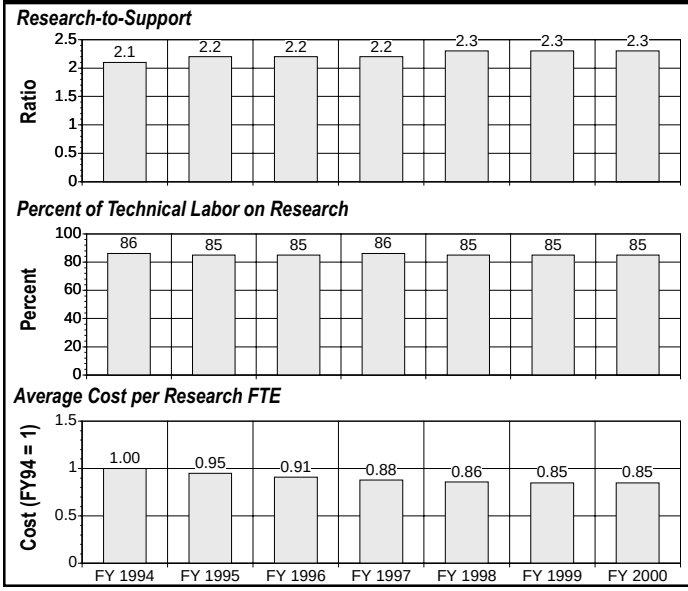
Oak Ridge National Laboratory

Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

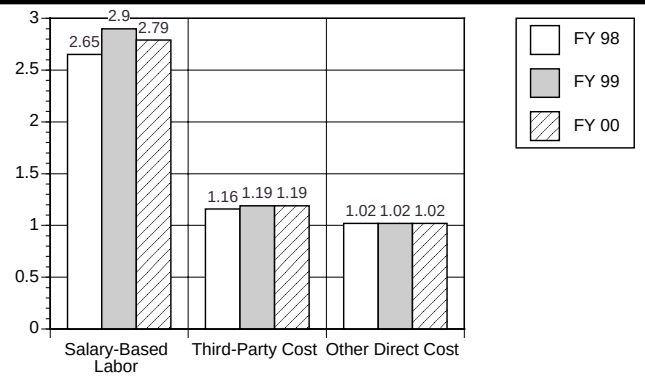
The Laboratory partners extensively with other organizations. Its 16 user facilities offer many opportunities for collaboration; more than 600 user agreements are in place. About 3,000 guests work at the Laboratory each year; 25% are from industry, and agreements with industry partners dominate new user facility activity. The Laboratory annually hosts hundreds of guest researchers from other nations. University partners come from 48 states; key partners include the University of Tennessee and six "core" universities: Duke, Florida State, Georgia Tech, North Carolina State, Virginia, and Virginia Tech.

Category/Mission	*Partner*	*Description*
Science	ANL, BNL, LANL, LBNL, TJNAF	Spallation Neutron Source project
	ANL, LBNL; U. Illinois, NIST; industry	Materials Microcharacterization Laboratory
	Tennessee universities and research institutions	Tennessee Mouse Genome Consortium to accelerate the development and analysis of mouse models for human diseases
	SEMATECH	Improvements to semiconductor manufacturing technology
	LANL, LBNL, LLNL, Stanford Human Genome Center	Joint Genome Institute, a DOE-sponsored collaboration in functional genomics bioinformatics
	ANL, LBNL, INEEL, LANL	DOE's Center of Excellence for the Synthesis and Processing of Advanced Materials
Science, Energy Resources	ANL, NREL, PNNL, SNL; universities	Biofuels Feedstock Development Program
	ANL, PNNL, universities	Center for Research on Enhancing Carbon Sequestration in Terrestrial Ecosystems (CSiTE)
	North Carolina A&T State U.	Collaborative research in high-temperature materials; NSF-sponsored Center for Advanced Materials and Smart Structures (with North Carolina State U.)
	ANL, LANL; NIST; universities, industry	High-temperature superconductor (HTSC) materials research and wire development; development of power conductors, electrical devices, and supporting technologies
Science, Energy Resources, Environmental Quality	U. Tennessee	Science Alliance; Distinguished Scientist Program; graduate programs; joint Institutes; joint research centers
	Federal agencies; GA, NC, TN	Southern Appalachia Man and the Biosphere Cooperative
Science, Environmental Quality	DOD, DOE, EPA; federal, nonfederal organizations	Strategic Environmental R&D Program
	Other DOE labs; universities	DOE's Environmental Management Science Program
Energy Resources	Industry; federal, nonfederal organizations	Partnership for a New Generation of Vehicles
	NREL, other DOE Labs	National Bioenergy Center, a virtual laboratory established by DOE to support technical improvements in efficient and economical use of biomass in agriculture and forest-based industries
	U. Tennessee; local and regional partners	National Transportation Research Center: partnership between public and private sectors to develop safe, affordable, and environmentally friendly transportation systems
Energy Resources, Environmental Quality	Nuclear Regulatory Commission	Nuclear safety, safeguards, and environmental protection activities; assistance in licensing and other regulatory actions and decisions
National Security	DOE labs and facilities	Interlaboratory Task Force on Unexploded Ordnance, in support of DOD
	Former Soviet Union	Initiatives for Proliferation Prevention; Nuclear Cities Initiative

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Pacific Northwest National Laboratory

Laboratory Information

Location: Richland, Washington

Number of Full-Time Equivalent Employees: 3,192 (as of April, 2000)

Scientific and Technical Degrees: 607 Ph.D's; 599 Master's; 534 Bachelor's

Contractor: Battelle

Accountable Program Office: Science

Field Office: Richland Operations Office

Web Site: http://www.pnl.gov

Funding Sources

Science: $68.1 million

Nuclear Energy: $0.4 million

Energy Efficiency and Renewable Energy: $21.0 million

Environmental Management: $45.8 million

National Security and Nonproliferation: $87.7 million

Fossil Energy: $3.9 million

Other DOE: $32.3 million

Non-DOE: $103.7 million

Total Funding: $363.0 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

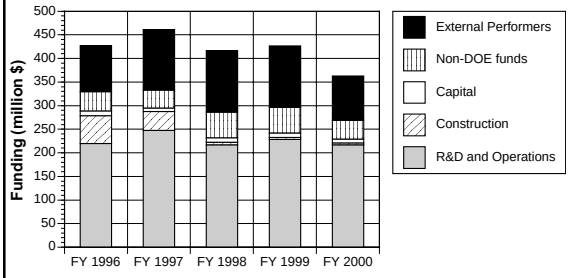
Pacific Northwest National Laboratory's core mission is environmental science and technology to meet critical national needs and solve major environmental challenges. The Laboratory is an outgrowth of the R&D component of the Manhattan Project Hanford Works that focused on materials science, nuclear technology, and health studies. Strengths in molecular and measurement science, process science and engineering, computational science, information visualization, materials science and engineering, and nuclear science and technology underpin our research programs. We operate the Environmental Molecular Sciences Laboratory, a national scientific user facility with advanced resources for fundamental research on the physical, chemical and biological processes. Our life science research focuses on the molecular basis of health effects from environmental pollutants. We solve legacy environmental problems with cost-effective cleanup solutions and technologies that prevent pollution and minimize waste. Our scientists identify technology to characterize and mitigate the consequences of pollution, climate change, and other environmental impacts as the basis for sound policy decisions. We develop clean energy and industrial processes, lightweight materials and advanced power systems for transportation, and efficient building technologies for DOE's energy mission. We provide arms control and non-proliferation support, reactor safety studies, and information protection for DOE's national security mission. The Laboratory strives for excellence in management and safe operations, thereby enabling efficient and cost-effective research while protecting our workers, the public, and the environment. Our staff are broadly engaged in local economic development, education, and other community programs.

Distinctive Competencies and Major Facilities

Pacific Northwest National Laboratory operates 196,000 square meters (2,106,000 square feet) of facilities, most of which are located in Richland, Washington. Our centerpiece is the William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), a national user facility for high-performance computing, high-field nuclear magnetic resonance spectroscopy, mass spectrometry, and surface science. Our life sciences laboratories support molecular biology, toxicology, genomic, microbial, and ecological research. The Radiochemical Processing Laboratory provides innovative processes for environmental cleanup and beneficial uses of radioactive materials, including hot-cells and radiochemistry facilities for nuclear fuel chemistry and waste characterization. The Process Science and Engineering Complex and the Applied Process Engineering Laboratory provide linked government and private-user facilities for thermal energy and chemical process studies. We also operate the Marine Sciences Laboratory in Sequim, Washington, for oceanic and estuarine ecosystem research. Our distinctive capabilities (below) underpin the Laboratory's research programs.

- Molecular Science: Chemical theory and dynamics, modeling and simulation, macromolecular structure and function, single-molecule optical and other spectroscopies, nanoscience and technology applications, synthesis, and chemical processes at interfaces.
- Computational Science: Advanced tools for simulating climate, chemical reactions, biological processes, and new-material manufacturing.
- Materials Science and Engineered Applications: Advanced synthesis and molecular-scale characterization of ceramics and lightweight materials.
- Environmental Science and Technology: Molecular to field-scale studies of the characteristics and performance of various subsurface and surface environmental systems, and broadly based assessments of land and marine ecologies, and site-restoration processes.
- Process Science and Engineering: Radiochemical separations, remote handling, bio-based and thermal processing, and material analyses.
- Nuclear Science and Technology: Reactor safety and component design, nuclear waste and fuel management, tritium and isotope production, nuclear nonproliferation, and ultrasensitive detection and identification of nuclear, chemical, and biological species.
- Economic and Social Sciences: Human, social, and economic consequences of energy generation and use, and human factors and interface design.
- Advanced Scientific Instrumentation: Tools and procedures for radiation measurement, mass spectrometry, nuclear magnetic resonance, microscopy, and optical and laser spectrometry.

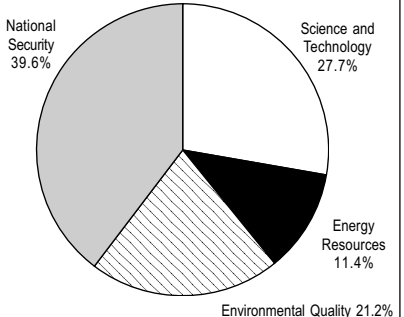
Funding by Activity



Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

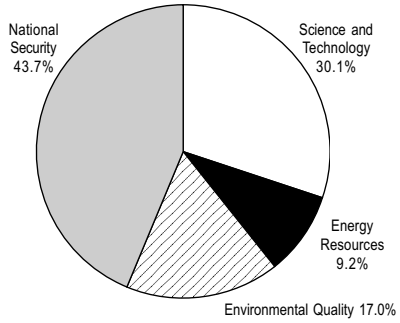
Funding by Mission Area

R&D Funding by Mission Area Total: $217 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $363 million



Note: Mission Footprint excludes remediation funds.

Pacific Northwest National Laboratory

Key Research and Development Activities

Science and Technology Mission: The Laboratory conducts basic and applied research in the environmental, chemical, biological, and materials sciences. We conduct research on contaminant transport in the environment and human health effects, global climate changes and impacts, protein characterization in cells, and computer simulations of complex biological and environmental systems. Activities include:

- Molecular-level studies of chemical structures at interfaces between different media, and nanoscale studies of the mechanisms and dynamics of interfacial reactions on atmospheric pollutant particles, materials in the subsurface, molecular-level synthesis, nanobiology, and advanced catalysts
- Studies on subsurface microbial systems and the mechanisms by which microbes can help remediate contaminated environments, including microbial cell research related to ecology, diversity, metabolism, transport, and response to contaminants
- Development of advanced chemical synthesis techniques for new materials and for new understanding of the environmental consequences, at the molecular level, of materials intended for lightweight vehicles, fuel cells, batteries, and biomedical applications
- Pharmacokinetic and molecular modeling to determine the complex and highly variable molecular and cellular responses to environmental contaminants
- Development of advanced scientific instruments and tools to support molecular science investigations and to perform ultrasensitive measurements for controlling chemical processes, characterizing hazardous wastes, and identifying environmental contaminants
- High-performance computer algorithms for modeling complex processes and systems such as subsurface contaminant movement and transformation, chemical reactions in complex environments, and performance of metals during high-deformation forming
- Measurement of atmospheric parameters to support advanced climate models and to assess regional consequences based on model predictions

Environmental Quality Mission: Principal research focus areas include retrieving and treating tank wastes and other radioactive and hazardous wastes; tank waste safety assessments; spent fuel materials and surface chemistry; characterizing, containing, and treating subsurface contaminants; managing land and marine ecosystems; and assessing the social, economic, health, and environmental policy problems and possible solutions. Activities include:

- Development of technologies to treat and immobilize stored radioactive and hazardous wastes; and technologies to remove, immobilize, and destroy subsurface organic and metal contaminants using chemical, thermal, and biological means
- Development and use of advanced techniques to monitor and characterize radioactive and chemical wastes, and contaminated soils and groundwater systems
- Development of tools and approaches for managing natural resources, for assessing ecosystem health and impacts from possible land uses, and for integrating the economic, social, and political factors that influence land-use decisions
- Studies of marine chemistry, ecological processes, resources, animal and plant health, and adaptive ecosystem management, with emphasis on characterizing the sources, fates, and effects of chemical contaminants
- Measurement of exposures to radioactive and chemical agents, and development and use of analytical tools to assess human health impacts
- Technical, social, and economic studies supporting life-cycle management and formulation of sound environmental policies and regulations
- Development and use of geohyrological models and data for predicting the performance of remediation technologies and waste disposal sites

National Security Mission: Research supports the U.S. objectives of nonproliferation and demilitarization of weapons of mass destruction and maintenance of defense readiness by developing, demonstrating and deploying technologies and systems that support the monitoring of treaties and agreements; detecting and analyzing physical and chemical "signatures" of weapons of mass destruction; design, development and demonstration of tritium production in light-water reactors and tritium-extraction technology; care and protection of humans in combat situations; enhanced information analysis and visualization for decision support; protection of critical elements of the national energy and communications infrastructure; and enhancement of law enforcement and anti-terrorism. Activities include:

- Development and use of ultrasensitive nuclear radiation detection and analysis systems to monitor creation and control of nuclear materials
- Development of integrated systems to detect, characterize and decontaminate biological warfare pathogens and chemical agents
- Development of strategies for threat vulnerability assessment, risk management, emergency response, information assurance, and infrastructure protection
- Design and demonstration of in-reactor assemblies and separations processes to produce tritium in light-water reactors for national defense
- Development of new sensors, data fusion, and non-destructive inspection technologies for extending the life of aging military systems and infrastructure
- Creation, use, and deployment of information visualization tools to facilitate rapid analysis of massive amounts of data, automatic text content discovery, and interactive visualization and analysis for national security and other missions
- Technical support to U.S. and Russian surplus plutonium disposition through development of immobilization and "burning" technologies
- Improving the safety of foreign nuclear reactors through emergency procedures and training, maintenance, designs for safety systems and fuel storage, and regulatory oversight

Energy Resources Mission: Principal research focus areas include advanced material and component designs for high-efficiency cars and heavy trucks; high-efficiency and low-cost modular solid-state fuel cells, standards and technologies for energy-efficient buildings; technologies for clean, productive, and sustainable industries of the future; and distributed power generation and electrical storage systems. Activities include:

- Design of lightweight materials (particularly metal alloys) and development of design and manufacturing techniques for high-efficiency vehicle components
- Development of engineered materials and system designs for fuel cells, batteries, and capacitors for transportation and distributed power generation
- Development of microtechnologies for compact power generation, man-portable heating and cooling, and chemical processing for fuel conversion
- Creation and use of computational mechanics and virtual prototyping to support component design, processing, and advanced lifecycle manufacturing
- Development of intelligent sensors and controls for vehicle operation and for improved efficiency, and for energy-efficient buildings
- Development and deployment of new technologies, controls, and energy standards to improve the energy efficiency of homes and buildings
- Development of new technologies to improve industrial processes, and to reduce both material requirements and process by-products in the forest product, glass, chemical, and agricultural industries

Pacific Northwest National Laboratory

Significant Accomplishments

Nanoscience and Technology (1998 to present): In this rapidly evolving science, the Laboratory developed methods to image and manipulate matter at the nanoscale level. We employed high resolution optical microscopy and spectroscopy to image molecular structures. We developed tailored molecular assemblies to produce self-assembled monolayers on mesoporous support materials for special applications in chemical separations, microelectronic circuits, and thin films and particles. We studied the properties of soft materials interfaces, photocatalysis, and nanoscale energetics. We synthesized dense, uniform arrays of aligned carbon nanotubes (containing single titanium carbide crystals) on titanium substrates, and demonstrated several important applications for nanostructured materials and assemblies.

Global Climate Assessment (1989 to present): The Laboratory advanced our understanding of the physical mechanisms underlying global climate change, assessed the regional impacts of changes, and evaluated potential mitigation methods. We helped establish and guide the Atmospheric Radiation Measurement Program, DOE's primary science program to study the role of clouds and atmospheric aerosols. Our regional climate modeling capability demonstrates the potential climate impacts of global warming. The Laboratory's second-generation economic model is a widely used tool for examining the effects of energy policy and technology change on greenhouse gas emissions and for understanding the costs and feasibility of alternative paths for stabilizing atmospheric carbon dioxide.

Computational Sciences (1989 to present): The Laboratory developed a new generation of computer codes for high-performance computing as research tools to address previously intractable scientific problems in the environmental and biological sciences. These codes, which run on massively parallel supercomputers, have important applications in computational chemistry, materials transport and biological process simulations, data mining, text processing and analysis, and visualization. The Molecular Science Software Suite, which includes NWCHEM, Ecce, and ParSoft, released in 1997, extends the size and scale of problems that can be accurately studied. This software received a 1999 R&D 100 Award and a 2000 FLC Technology Transfer Award, and is receiving broad academic, national laboratory, and industrial use. We developed advanced algorithms for remote sensing of large-scale earth features, for nondestructive characterization of materials, for enhanced medical image processing, and software for collaborative problem-solving environment to support the modeling and simulation of complex scientific problems. We developed highly successful visual information mining software for intelligence analysis, law enforcement, public health, patent analysis, and logistics. And we developed technologies for protecting computer networks, systems, and data storage from subversive activities.

Molecular and Cellular Biology (1988 to present): The Laboratory developed methods for assessing the effects of low-level toxins in biological systems and for analyzing the interactions of repair enzymes and other regulatory proteins associated with damaged DNA. We developed theoretical and spectroscopic approaches for understanding mechanisms involved in mutagenesis, carcinogenesis, and structural abnormalities using contemporary tools (sequencing, chromatography, enzyme-linked immunosorbent assay, mass spectrometry, nuclear magnetic resonance spectroscopy, and microscopy). We pioneered new ion trap mass spectrometry and ion funnel technology for rapidly detecting and identifying critical biomolecules and for characterizing cellular protein distributions (proteomics).

Arms Control and Nonproliferation (1988 to present): The Laboratory improved the international community's compliance monitoring of arms control treaties and the potential diversion or creation of weapons of mass destruction. We developed statistical techniques for analyzing seismic activity from weapons tests. We developed automated instruments (such as the R&D 100 Award-winning radionuclide aerosol analyzer and the automated radioxenon analyzer) and other sensitive nuclear detection technologies and systems for monitoring treaty compliance, weapons proliferation, and illicit materials trafficking. We created safeguards and security programs for accountability and control of special nuclear material in the U.S. and abroad. Our work on information analysis, dismantlement of nuclear warheads, cleanup and accountability of nuclear materials in North Korea, and fissile materials disposition have increased world security. We helped manage the Nuclear Cities Initiative, which helps the Russian Federation reduce the size of its nuclear weapons establishment, and redirects the work of nuclear weapons scientists.

Subsurface Science (1983 to present): The Laboratory researched contaminant transport and fate in the subsurface environment. We developed computer models that incorporate biogeochemical and hydrogeologic processes, predict chemical species, and show how they move in the subsurface. We identified microorganisms in the deep subsurface that may aid in remediation methods, such as in situ redox manipulation (R&D 100 in 1998), which modulates the subsurface geochemistry to immobilize contaminants.

Energy Technologies (1972 to present): The Laboratory helped to develop energy efficient building standards, metering equipment, and design tools such as MECcheck (1997 FLC award). Staff worked with industry groups and more than 20 states to deploy these tools and standards, which are projected to save U.S. consumers $2 billion annually in lower energy costs. We developed new microtechnologies to improve or replace current mobile and distributed power systems. Through public-private partnerships, the Laboratory developed lightweight materials and manufacturing techniques to build new cars and trucks that will meet fuel-efficiency goals. We helped develop energy efficiency centers in Moscow, Beijing, Kiev, and other Eastern European cities, which are challenged by aging technologies and inefficient systems. We extended our materials chemistry and ceramic processing capabilities in solid oxide fuel cells to focus on whole fuel cell system design, modeling, and fabrication.

Waste Management and Environmental Technologies (1965 to present): The Laboratory characterized and evaluated problems of legacy nuclear and chemical wastes and contaminated sites. We developed options for high-level nuclear waste disposal, screened potential repository sites, and demonstrated the suitability of waste forms and treatment options, including vitrification. Waste vitrification technology is now being applied at several DOE cleanup sites. We lead the national Tanks Focus Area to develop, test, retrieve, and pre-treat the Department's radioactive tank wastes. We are developing technologies to solve DOE and industrial environmental problems, including new chemical separations, methods to reducing waste volumes, techniques to manipulate the subsurface and destroy or contain contaminants, processes for treating and immobilizing high level wastes, and advanced robotic systems for performing hazardous work.

Radiation and Chemical Health Effects (1950 to present): The Laboratory conducted fundamental radionuclide toxicology and radiation biology studies in support of radiation protection standards. We developed new instruments, materials, calibration methods, and facilities for detecting and analyzing radiation and chemical agents. These tools protect workers, workplaces, and the environment. Recent accomplishments include broad application of the more sensitive optically stimulated luminescence dosimeters (R&D 100 winner in 1992 and 1999), and real-time dosimeters for the Space Shuttle. We also developed real-time "breathalyzer" monitors to measure worker exposures to hazardous chemicals and toxic agents.

Nuclear Science and Technology (1950 to present): The Laboratory contributed to civilian nuclear power in power system design, technical foundations for regulations, operator training and qualification, and reactor safety. Accomplishments include alternative reactor designs; development and commercialization of fuel design, fabrication, and reprocessing techniques; design support to the Fast Flux Test Facility; demonstrating tritium production in light-water reactors; and purification of derived isotopes for medical and industrial applications. The Laboratory was a major contributor to the first quantitative assessment of reactor accident risks, and to the resolution of critical materials and other technical issues affecting reactor safety and regulation. The Laboratory also supported DOE's health and environmental response to the Chornobyl accident, and is making significant contributions to improving the safety of the nuclear industry in the former Soviet Union.

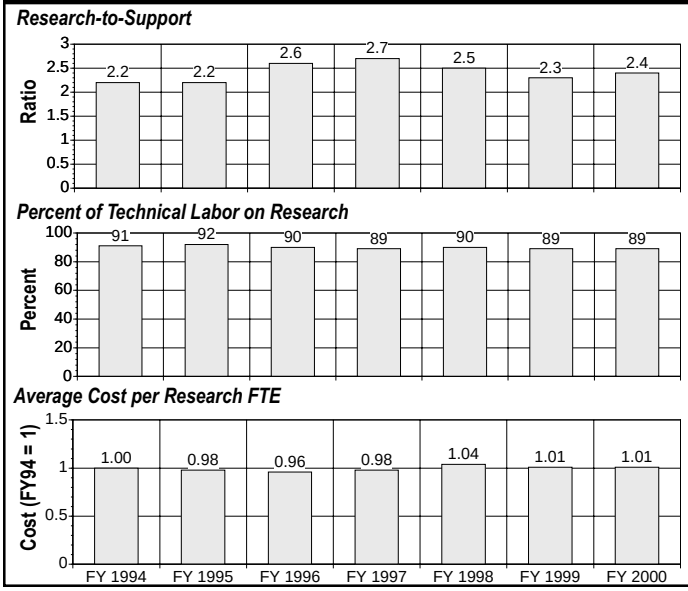
Advanced Scientific Instruments (1950 to present): The Laboratory has long been actively involved in developing and testing advanced instruments for research in a broad area of technologies for detection and analysis in support of scientific research. In recent years (1992-present), we increased the sensitivity, precision, and analytical usefulness of mass spectrometers and associated hardware for protein identification and rapid detection of chemical and biological agents. Continued progress in nuclear magnetic resonance spectroscopy and microscopy provided new information on tissue composition and the functions and structures of complex biomolecules. We improved matrix-assisted laser desorption and ionization mass spectrometry for rapid detection of microorganisms, and we advanced high-performance field-portable electrospray ionization Fourier transform ion cyclotron resonance instrumentation. Advanced scientific instruments have important applications in national security, health, and environmental research. These important new technologies resulted in several R&D 100 awards, technology transfer awards, and commercial applications.

Pacific Northwest National Laboratory

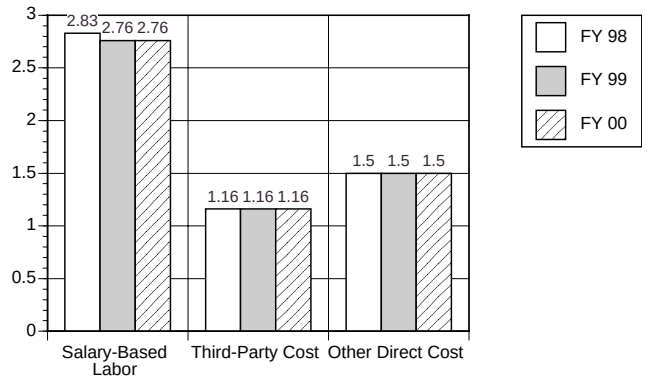
Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

Category/Mission	Partner	Description
Science & Technology		A wide range of academic partnerships promote scientific discovery and education. Laboratory and industrial partnerships bring together the best talent to address DOE's most challenging problems, and open EMSL's facilities to the broader scientific community.
	Universities, industrial partners, and foreign research institutes	Environmental Molecular Sciences Laboratory (EMSL). The EMSL serves as a center for collaborative scientific research for the national and international academic and industrial community, with nearly 1000 users. It houses state-of-the-art research instruments for studying surface and molecular chemistry, advanced molecular and cellular biology, and computational modeling and simulation.
	DOE national laboratories and universities	Atmospheric Radiation Measurements (ARM). ARM is a DOE global climate change research project to resolve scientific questions about greenhouse gases and their impact on global climate. Long-term field measurements are obtained to study the distribution of energy and water in earth's climate system.
	Oregon Health Sciences University, Oregon State University	National Institute of Environmental Health Sciences (NIEHS) Superfund Basic Research Programs. This program established the Superfund Basic Research Center. Research will focus on neurotoxicants associated with Superfund cleanup sites, such as volatile organic compounds. Research will also address biomarkers, methods for bioremediation, and physiologically based pharmacokinetic modeling.
	7 DOE laboratories, 15+ universities, and two industrial partners	Natural and Accelerated Bioremediation Research (NABIR) Program. This is a DOE/OBER fundamental science research program on subsurface biological systems and their application to bioremediation.
	University of Washington	Northwest Institute for Nanoscience and Technology. This joint research institute supports our Laboratory-level initiative in nanoscience and will strengthen capabilities in biomaterials and in surface science. Capabilities within the EMSL complement the strong biomaterials component at the University. This collaboration also involves education and training opportunities.
	Princeton, Columbia, Northwestern University, and DOE laboratories	Environmental Molecular Sciences Institutes. This National Science Foundation partnership with DOE creates interdisciplinary, collaborative opportunities for scientists at the national laboratories and universities to work with industry on problems associated with effects of technology on the global environment.
Environmental Quality		Laboratory, industry, and university partnerships span the development lifecycle from basic science to final deployment, and provide comprehensive solutions to DOE's complex environmental problems--and related problems facing industry.
	DOE national laboratories, universities, and industrial partners	Environmental Management Science Program (EMSP). The focus of the Laboratory's projects under this program is managing tank wastes, in situ treatment of groundwater, and health effects. We partner with several organizations on projects where the work directly supports critical DOE science needs for cleanup.
	DOE laboratories and contractors, universities, and industrial partners	Tanks Focus Area. This program develops technologies to safely and efficiently remediate radioactive waste in storage tanks at four DOE sites. The multi-laboratory teams, with industry partners, have delivered new waste retrieval systems, characterization tools, and treatment processes.
	University of Washington and other northwest regional universities	Partnerships bring together the resources and highly specialized expertise needed to address the multidisciplinary nature of many national security issues, such as counter-terrorism, weapons nonproliferation, and information security.
National Security		Partnerships bring together the resources and highly specialized expertise needed to address the multidisciplinary nature of many national security issues, such as counter-terrorism, weapons nonproliferation, and information security.
	DOE laboratories, U.S. firms, and host countries	**International Nuclear Safety Program.** This program reduces risks of operating Soviet-designed nuclear reactors by working cooperatively with host countries of the former Soviet Union on nuclear safety and supporting technical infrastructure.
	University of Washington and other northwest regional universities	**Pacific Northwest Center for Global Security.** This Center links PNNL with northwest universities to enhance the information, contracts, and expertise available to the Laboratory's Arms Control and Nonproliferation program.
Energy Resources		Partnerships provide essential information about the technical issues facing energy providers and energy consumers, and provide industrial involvement from basic research, through development, to ensure direct deployment of the results in industry.
	DOE laboratories and industrial partners	Solid-State Energy Conversion Alliance (SECA). This partnership works to pool capabilities in materials sciences, chemical processing, sensors, and modeling to develop and mass-produce clean, affordable, and high-efficiency modular solid-state fuel cell technology.
	State and federal government, industrial partners, and DOE laboratories	Building Standards and Guidelines. PNNL chairs the largest energy standard-setting committee for the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. PNNL also has helped more than 20 states adopt, upgrade, implement, and enforce their building energy codes.
	Several universities and industrial partners	Northwest Alliance for Transportation Technology. This public-private partnership addresses transportation technology goals. Its focus is to develop low-cost, lightweight materials and tailored manufacturing processes to achieve the 40 percent weight reduction goals for a New Generation Vehicle.

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Sandia National Laboratories

Laboratory Information

Location: Albuquerque, New Mexico
Number of Full-Time Equivalent Employees: 7,371
Scientific and Technical Degrees: 3,646
Contractor: Lockheed Martin Corporation
Accountable Program Office: Defense Programs
Field Office: Albuquerque Operations Office
Web Site: http://www.sandia.gov

Funding Sources

Science: $36.9 million
Nuclear Energy: $2.0 million
Energy Efficiency and Renewable Energy: $46.9 million
Environmental Management: $34.4 million
National Security and Nonproliferation: $903.1 million
Fossil Energy: $6.1 million
Other DOE: $50.3 million
Non-DOE: $320.6 million

Total Funding: $1,400.3 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

Sandia National Laboratories is a national security laboratory established in 1949 to support the design, development, production, and testing of nuclear weapons; assure product quality; monitor weapon quality throughout stockpile life; and assure nuclear safety of the entire weapons stockpile. Sandia currently testifies to the safety of over 90% of the non-nuclear components in the nation's nuclear weapons. Sandia is a multiprogram national laboratory that provides scientific and engineering solutions to meet national needs in nuclear weapons and related defense systems, energy security, and environmental integrity, and addresses emerging national challenges. The Laboratory has a heritage in nuclear weapons quality, reliability, safety, and use control, coupled with a need to work closely with industry to produce products. This gives it a unique ability to contribute systems and components to solve major national challenges. These challenges include: ensuring that the nuclear weapons stockpile is safe, secure, reliable, affordable, and fully capable of indefinitely supporting our nations deterrence policy; reducing the vulnerability of our nation to proliferation and use of weapons of mass destruction, nuclear incidents, and environmental damage; enhancing the surety (safety, security, and reliability) of energy and other critical infrastructures; and developing high impact responses to emerging national security threats.

Distinctive Competencies and Major Facilities

Nuclear stockpile stewardship is the Laboratory's most distinctive competency. It combines component development and systems engineering with the ability to design and demonstrate that systems are safe, secure, and reliable. As extensions of its weapons stewardship, Sandia conducts research and development to protect critical infrastructures, support nuclear nonproliferation, and counter threats of weapons of mass destruction through science-based engineering.

— Engineering Sciences provides research, development, and application of experimental discovery, computational modeling and simulation, and full-scale test for many processes and products. Staff use experimental observation to develop/validate physics-based phenomena, develop engineering models for computational simulation, and quantify model and experimental uncertainties. The Engineering Sciences Experimental Facilities, Combustion Research Facility, Joint Computational Engineering Lab, TeraOp Computing Facility, National Solar Thermal Test Facility, and Photovoltaic Sciences Facility support this.

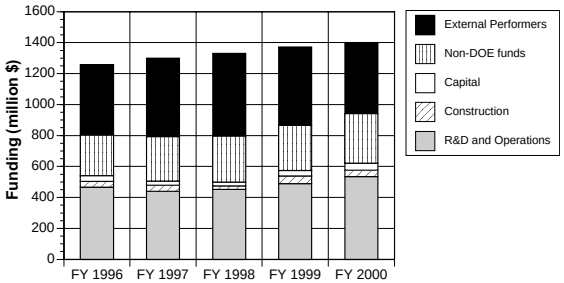
— Materials and Process Sciences research focuses on polymers, ceramics, and metals in nonnuclear components of the stockpile to identify important properties, understand how they change with time, and develop new/replacement materials and processes. Subprograms provide science-based understanding of how macroscopic properties depend on nanoscale characteristics (e.g., composition, microstructure), how to make parts faster, cheaper, more reliable, and how materials age. The Integrated Materials Research Lab, Process and Environmental Technology Lab, Integrated Microsystems Technologies Lab, Advanced Materials Lab, Thermal Spray Research Lab, Liquid Metal Processing Lab, and Advanced Manufacturing Processes Lab support this.

— Microelectronics and Photonics Sciences focus on designing/ making radiation-hardened integrated circuits and integrated microsystems to sense vibration, chemicals, or temperature, perform mechanical work, and communicate without wires or fibers. The Microelectronics Development Lab, the Compound Semiconductor Lab, and the Processing and Environmental Technology Laboratory (PETL) supports these efforts, as will the Microsystems Engineering Sciences and Applications Complex, if funded. The Microsystems and Engineering Sciences Applications (MESA) complex is under development within DOE (conceptual design completed in May 2000) to integrate new technology with advanced computation for the benefit of modernizing electrical, mechanical, and optical components for nuclear weapon safety, security, and reliability.

— Computational and Information Sciences develops technologies that are revolutionizing engineering and manufacturing. Sandia develops new mathematical methods, algorithms, and software and explores how multiple computers may interact over long distances, and how large parallel-processing computers may be "grown" from off-the-shelf components. The Massively Parallel Computing Research Lab and the Virtual Laboratory Testbed support these efforts.

— Pulsed Power Science research provides radiation environments to certify survivability of strategic systems in the stockpile and to support the Department's Stockpile Life Extension Program. In addition to simulating weapons effects, the Laboratory uses its operating accelerators to explore weapons physics, nuclear fusion reactions for the Stockpile Stewardship Program. Sandia uses these facilities to develop and support other defense, civilian, and basic science applications. The Z Facility is the world's most powerful x-ray source.

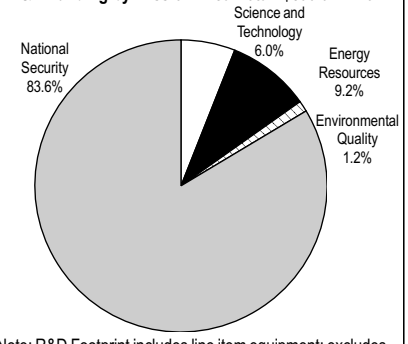
Funding by Activity



Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

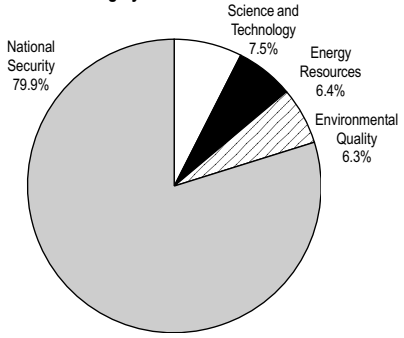
Funding by Mission Area

R&D Funding by Mission Area Total: $599.9 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $1400.3 million



Note: Mission Footprint excludes remediation funds.

Sandia National Laboratories

Key Research and Development Activities

National Security Mission

— **Nuclear Weapons:** Sandia National Laboratories has responsibility for integrating nuclear explosive subsystems with the myriad of non-nuclear components and subsystems necessary for safe, secure, reliable and deployable nuclear weapons. Sandia is the central interface with the DoD for weapons requirements, system design and integration, surveillance, maintenance, training and logistics, and dismantlement.

— **Stockpile Systems:** Sandia is responsible for annual certification; hostile and normal environment testing (e.g., B61-11 flight testing); stockpile surveillance; system and component design engineering (e.g., W76 AF&F); and advanced and exploratory studies (e.g., HDBT studies)

— **Manufacturing Systems Science & Technology:** Sandia has primary responsibility for Neutron Generator Production (e.g., MC4380). Sandia is also responsible to the Nuclear Weapons Complex for the MDE program and the Primary Standards Laboratory.

— **Model-Based Design & Manufacturing Integration:** With the end to underground testing, model-based design and manufacturing is critical to assuring the safety, security and reliability of the enduring nuclear stockpile. The laboratory is engaged in several important activities including materials and physics models; 3-D, full system STS simulation development; validation experiments for models used in system and component designs; production-ready LIGA technology and decision support tools for the NWC.

— **Science & Technology:** Designing and maintaining the nuclear weapons stockpile to US standards of safety, security, reliability, and performance can only be accomplished with a set of state-of-the-art capabilities in science and technology. Sandia maintains such capabilities in materials processing and aging, radiation effects sciences, microsystems design and fabrication, nanoscale materials manipulation and design, pulsed power, and massively parallel computing hardware and software. These capabilities are employed by Sandia to meet our weapons stewardship responsibilities from weapon conception through retirement.

— **Microsystems:** As the current stockpile ages, Sandia will work with the rest of the NWC to refurbish the remaining set of nuclear weapons. This series of scheduled refurbishments will provide an opportunity to make needed enhancements to the surety (safety, security, and reliability) of these weapons. The central new competency Sandia will bring to bear on this problem is microsystem technology. Sandia is a world leader in radiation-hardened microelectronics, microelectromechanical systems (MEMS), and LIGA technology (for fabrication of small metallized components). The completion of the planned Microsystems Engineering and Science Applications (MESA) facility in New Mexico and the LIGA Technology Laboratory (LTL) in California

— **Inertial Confinement Fusion:** The Laboratory's Z Accelerator is the premier pulsed power source in the world to study inertial confinement fusion and weapon physics applications. Today, x-ray energy output is greater than 2.0 megajoules, a power of 290 terawatts has been achieved, and hohlraum temperatures have exceeded 150 electronvolts.

— **Nonproliferation and Arms Control:** The Laboratory provides research and development for a variety of systems that detect proliferation of weapons of mass destruction, verify international agreements, enhance physical protection at Department facilities, and assist the Department in its intelligence mission. Two important aspects of these program areas are information management and support for enhanced control of special nuclear material. Also, the Laboratory's Cooperative Monitoring Center is used by a number of countries and agencies to evaluate the applicability of arms control technologies and procedures to regional security issues.

— **Technologies for Intelligence Functions:** Sandia's support for the intelligence community focuses on foreign technology assessment and technology development. It provides tools for assessing information relevant to the proliferation and delivery of weapons of mass destruction.

— **Identification of Nonproliferation Technologies for Emerging Threats:** The Laboratory is developing systems and technology for detecting and characterizing proliferation-related activities, including chemical weapons, biological weapons, and missiles. In conjunction with Los Alamos National Laboratory, Sandia is developing a satellite-based, multispectral thermal imaging system. In addition, it is developing specialized chemical microsensors, bioinformation systems, and decontamination technology for detecting and countering nuclear, biological, and chemical weapons.

— **Advanced Conventional Weapons Technologies:** The Laboratory develops synthetic aperture radar systems and processing algorithms for national security applications that may require all-weather, day-and-night capabilities.

Environmental Quality Mission

The Laboratory's Environmental Technology Development Program encompasses a range of customer application needs. Our work covers technology development for waste management, environmental restoration, information management and decision support, and monitoring/sensor applications.

It is responsible for scientific studies and performance modeling to enhance and demonstrate the long-term behavior and containment properties of the Waste Isolation Pilot Project repository and its suitability for long-term disposal of the Department's transuranic waste.

Energy Resources Mission

The Laboratory is improving energy infrastructure surety and energy production, conversion, and use. Its programs include solar electric technologies, wind energy, geothermal energy systems, fossil energy programs, electric power distribution systems, and energy storage systems for utilities. The Laboratory's concentrating solar power programs work with users and manufacturers to improve reliability, decrease costs, and increase acceptance of these technologies for power generation.

Science and Technology Mission

— The Laboratory maintains numerous projects that contribute to the Department's science and technology mission. These projects include research in fusion energy sciences, scientific computing, basic energy sciences, and biological and environmental research.

— In fusion energy sciences, interaction of plasmas and materials and the interface of plasmas and fusion reactor walls are studied. Scientific computing includes work on numerical methods with a focus on massively parallel computing, software infrastructure research, and distributed computing techniques.

— Under basic energy sciences (BES), Sandia's largest project in chemical sciences is housed in the Combustion Research Facility, a DOE User Facility, where advanced research methods are developed and applied to the study of fundamental combustion processes. Materials sciences emphasizes artificially structured materials, nanoscale science, ceramics and ordered organic/inorganic composites, advanced techniques in synthesis and processing, defects and impurities in solids, and computational materials science. BES geoscience research improves understanding of near-surface geological processes; BES engineering sciences address principles that underlie engineering problems in energy technologies.

— In biological and environmental research, Sandia employs expertise in remote sensing, field testing, and systems engineering to assist both the Atmospheric Radiation Measurement Program and its airborne adjunct, the Atmospheric Radiation Measurement Unmanned Aerospace Vehicle Program.

— New initiatives are being developed in the area of nanosciences to exploit novel properties and phenomena that result from control of materials and structures on the nanometer scale. Our intent is to provide focus for multidisciplinary research in materials science, chemistry, physics, biology, and microfabrication through cooperative research networks and through a nanoscience integration center.

Sandia National Laboratories

Significant Accomplishments

1999: Maintaining the safety, security and reliability of the stockpile, the laboratory qualified the MC4380 Neutron Generator and its timer, voltage bar, rod, current stack and neutron tube for use in the Navy's W76 weapon system; developed a coupled 3-D age-aware model on the teraflops computer of the explosive firing set used in the W76 and W78 systems in support of the Enhanced Surveillance and Dual Revalidation programs; produced an electrostatic comb actuator using Sandia's Ultra-planar, Multi-level MEMS technology (SUMMiT V), and successfully flew the first W76 Enhanced Fidelity Instrumented (EFI) test unit.

1996-1999: Certification of the U.S. Nuclear Weapons Stockpile: Each year, certify with Lawrence Livermore and Los Alamos National Laboratories that no nuclear testing was needed to ensure the safety and reliability of the nuclear weapons stockpile.

1998: Met all Departmental commitments: retrofit B83-0; completed B61-7 Stockpile Life Extension Program; provided safety upgrades for B61-3, 4, and -10; provided neutron tubes; conducted fire safety assessment of W80; retrofit B61 as earth-penetrator (B61-11) to replace B-53; and developed and installed a new weapon code management processor.

— Developed compliance monitors for the Comprehensive Test Ban Treaty, upgraded nuclear security in the Former Soviet Union, developed a hand-held device to characterize and monitor radioactive materials, and earned Waste Isolation Pilot Project EPA certification. Restarted the Annular Core Research Reactor for medical isotopes, developed an explosives-detection portal for the FAA, and disabled the Unabomber's last bomb. Tested warheads against hardened structures, operationalized ground sensors to identify mobile missile launchers, and launched ballistic missile defense test vehicles.

— Set record on Z-Machine for temperature and x-ray output (290 terawatts); demonstrated electron "tunneling" quantum transistors up to 10 times faster than current transistors; fabricated photonic crystals to bend infrared light without loss; and developed new thin films for chemical warfare and microelectronics applications.

1996–1997: Maintained the reliability, safety, security, and operational readiness of the nuclear weapons stockpile during rapid transition in the size and makeup of the stockpile. Included system-level design for weapon dismantlement and consolidated production responsibilities for the nuclear weapons complex. Developed a new generation of silicon-based micro-machines that are smaller than the diameter of a human hair, generating useful power, and operating at hundreds of thousands of revolutions per minute. Developed a prototype microelectromechanical system lock.

— Developed advanced synthetic aperture radar and automatic target recognition technologies for intelligence, arms control, and battlefield applications. Synthetic Aperture Radar used to create digital elevation maps (with a height accuracy of a few centimeters) and could be used in guidance systems (with better than 3-meter accuracy).

— Implemented an integrated suite of satellite and ground station detection systems, now receiving data from remote monitoring equipment.

— Designed an automotive airbag to reduce volume and weight by 60 percent (reducing air bag induced injury); provided first extraterrestrial use of airbag for soft landing of Mars Sojourner; and set record for computing speed (1.81 teraflop) as part of ASCI.

1990–1995: Began providing all neutron generators, microelectronics, frequency and magnetic devices, pyrotechnical devices, thermal and chemical batteries, capacitors, and ceramics for nuclear weapons. Developed a radiography system to determine precise location of hazardous materials in weapons and an abrasive water jet to remove them, greatly speeding dismantlement. Provided engineering support to disassemble the last B57 and the last W68. Initiated project to preserve expertise of nuclear weapons engineers and scientists.

— Began activities to ensure efficient, safe, and secure transportation and sequencing stockpile dismantlement in the United States and the Former Soviet Union. Developed remote bomb disablement technologies now used worldwide. Began studies for the Defense Nuclear Agency of the Russian Topaz II thermionic space nuclear power system as a possible replacement for US thermoelectric systems.

— Used supercomputing to model impacts of comet fragments that struck Jupiter and to model structural dynamics of an entire ship for Navy redesign following mine damage to the USS Princeton. Determined probable cause of USS Iowa gun turret explosion.

— Contributed to the Partnership for a New Generation of Vehicles to develop low-emission automobile propulsion.

1980–1990: Delivered weapon systems including the W-79 artillery shell, W-80 air-launched cruise missile, B-83 strategic bomb, W-84 ground-launched cruise missile, W-87 reentry vehicle weapon system, and the W88 fuze for the Mark V Trident submarine-launched ballistic weapons system. Provided flight tests, vulnerability studies, countermeasures, conceptual studies, weapon system designs, lethality studies, and targeting algorithms in support of the Strategic Defense Initiative Organization.

— Invented strained-layer superlattice materials consisting of many thin layers (each a few tens of angstroms thick) of alternating single-crystal semiconductor materials. The combination of thin layers, lattice strain, and novel patterning allows tailoring properties of materials. Sandia is currently using these new semiconductors to develop high-speed field-effect transistors, optoelectronic emitters, detectors, novel optoelectronic mirror devices, and broadband light sources.

— Developed a semiconductor bridge to ignite explosives a thousand times faster than existing devices. Developed break-beam infrared profiling system for the Technical On-Site Inspection. Used a Cray supercomputer to factor a very large integer to test the security of an encryption algorithm. Began operation of Solar One, the first commercial US solar-electrical generation plant.

1960–1980: Created and implemented nuclear safety "weak link/strong links" to prevent unintentional nuclear detonation in normal use and accidents. Created and delivered electromagnetic Permissive Action Links to prevent the accidental or unapproved use of nuclear weapons. Developed simulation tools for nuclear weapons effects (neutrons, electrons, gamma rays, and x-rays) on components and designed radiation-hardened components and systems. Developed advanced arming and fuzing for the Poseidon and Trident missiles. Designed and developed weapon components and systems, including the B61 lightweight tactical thermonuclear bomb, compatible with 22 kinds of aircraft and a building block for a depth bomb, missile warhead, and extended range bomb.

— Invented the laminar flow clean room; multiple, independently (targetable) reentry vehicle; rolamite inertial switch for weapons safing; and lead lanthanum zirconate-titanate (PLZT) goggles to protect pilots from flashblindness and permanent retinal burns from nuclear explosions.

— Established a combustion research facility to study combustion processes. Provided full-scale geological systems engineering for Waste Isolation Pilot Project.

1947–1960: Established a nuclear weapons production system yielding very high-quality and high reliability weapons. Conceptualized the "wooden bomb" design to produce a fully assembled, on-call nuclear device storable for 20 years without major maintenance. Engineered the "zipper" initiator, "one-shot" transducer fuzes, and thermal batteries to support the wooden bomb. Developed a "laydown" bomb controlled by a parachute to mitigate shock to bomb components. Developed new parachute designs and shock absorbing systems.

Sandia National Laboratories

Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

Background. The technology base developed through our work for the DOE has established expertise and capabilities not found in industry or in other government agencies. Opportunities exist to contribute technological solutions to entities other than the DOE. This benefits the DOE by leveraging multiagency funds and helping maintain abilities to perform DOE missions. Major activities in WFO include conventional defense, strategic defense, counterproliferation and nonproliferation, treaty verification, environmental cleanup and monitoring, energy uses, high-performance computing, safeguards and security, radiation effects, materials development and characterization, law enforcement, microelectronics, manufacturing, photonics, robotics, transportation, and space efforts.

Funding Sources. Of the $299.2M total, $243.2 was received from Other Federal Agencies (OFAs), $34M from CRADAs, and $23M from Non-Federal Entities (NFEs). DoD ($181M) dominated the OFA funding where the Air Force ($86M), Army ($36M), and Navy ($21M) were the largest contributors. The rest of the OFA funding ($62M) comes principally from compartmentalized work, support of intelligence agencies, and the Nuclear Regulatory Commission (NRC).

OFA activities. Examples of the activities under OFA collaborations follow:

— *Air Force.* The Laboratory provides research and development, prototyping, modeling and simulation, proof of concept, and hardware and software deliverables. Testing, studies, and data analysis are other common deliverables. Technology is provided in the areas of remote sensing and verification, environment and energy, safeguards and security, command and control, military systems, microelectronics, aerospace systems, and component engineering.

— *Army.* The Laboratory provides technology in the areas of environment, aerospace systems, military systems, safeguards and security, testing facilities and conditions, microelectronics and photonics, high-performance computing, international security, transportation, and applied energy. Other collaborations include nuclear weapons transport, safing and arming technology, parachutes, target recognition, battlefield survivability, land mines imaging, radiation testing, and robotics.

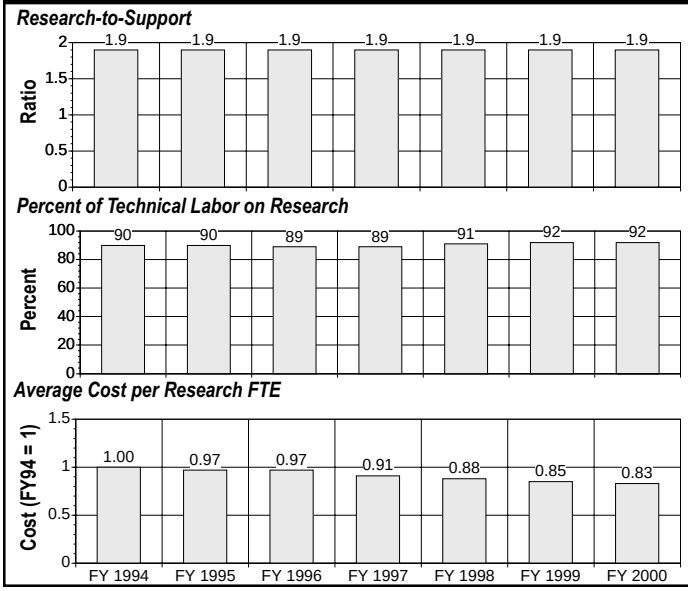
— *Navy.* The Laboratory provides technology in the areas of nuclear weapons safing and arming, conventional weapons effects, mine detection, environmental effects, materials characterization, missiles, robotics, component engineering, aerospace systems, high-performance computing, command and control, and information surety.

— *NRC.* The Laboratory provides research, analysis, and technical assistance in the safety assessment and licensing of commercial nuclear fuel-cycle facilities. The primary emphasis concerns reactor safety research; lesser but significant emphasis concerns decontamination and decommissioning safety.

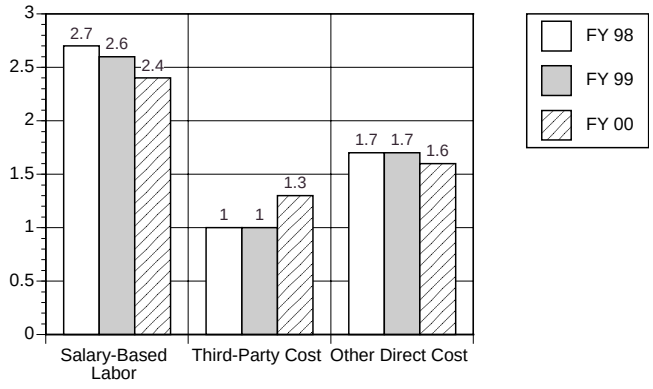
CRADAs. Since their inception at SNL in 1990, we have had 410 CRADAs with a total funds-in value of $162M. However, 10 CRADAs with four principal partners have resulted in $122.6M or 75% of this total. These principal partners are the EUV Limited Liability Corporation (to develop a U.S. capability to build sub 0.1 micron electronic circuits), SEMATECH Inc. (to develop advanced semiconductor manufacturing equipment), Goodyear Tire and Rubber Company (for modeling tools and manufacturing processes that reduce processing costs and improve the quality and safety of tire and rubber products), and U.S. Advanced Battery Corporation (for R&D on rechargeable batteries).

— NFE. Our NFE activities derive from and support our DOE missions. The largest support comes from NFEs interested in our work on scanning array radars, reactor safety, engine combustion, shipping containers, testing facilities, and smart cards for computer and information security.

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Ames Laboratory

Laboratory Information

Location: Ames, Iowa
Number of Full-Time Equivalent Employees: 310-Estimate
Scientific and Technical Degrees: 71 Ph.D's; 14 Master's ; 16 Bachelor's
Contractor: Iowa State University
Accountable Program Office: Science
Field Office: Chicago Operations Office
Web Site: http://www.external.ameslab.gov

Funding Sources

Science: $19.9 million
Nuclear Energy:
Energy Efficiency and Renewable Energy:
Environmental Management: $0.9 million
National Security and Nonproliferation: $0.7 million
Fossil Energy: $0.5 million
Other DOE:
Non-DOE: $1.5 million

Total Funding: $23.5 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

Ames Laboratory is a national center for the synthesis, analysis and processing of new materials and in the science and engineering of these materials for advanced energy and environmental applications. Ames was established in 1947 to develop processes for the production of uranium metal in large quantities. Ames Laboratory now pursues much broader priorities in additional to the materials research that has given the Laboratory its signature. The Ames Laboratory conducts fundamental research in the physical, chemical, materials, and mathematical sciences and engineering which underlie energy generating, conversion, transmission and storage technologies, environmental improvement, and other technical areas essential to national needs. In its association with Iowa State University, Ames plays a significant role in the education of students in science and engineering. The Materials Preparation Center provides specialized materials to the research community worldwide.

Distinctive Competencies and Major Facilities

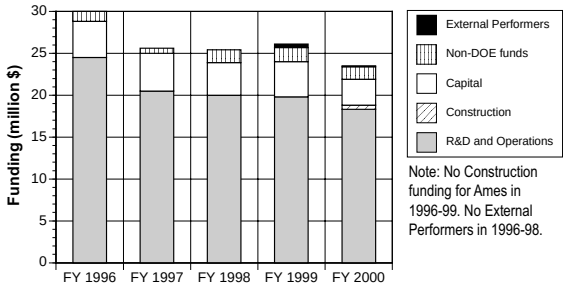
Ames Laboratory has nine scientific program areas; most funded through the DOE's Office of Science (SC) program. They are Applied Mathematics and Computational Sciences, Biorenewable Resources, Condensed Matter Physics, Environmental and Protection Sciences, Materials Chemistry, Metallurgy and Ceramics, Molecular Processes, Nondestructive Evaluation, and Physical and Biological Chemistry. The Programs perform research in the areas of synthesis and processing of rare-earth materials with unique purity, crystal structure and desirability, metals and intermetallics, ceramics, polymers, advanced computing systems, parallel computing, forensic science and instrumentation, monitoring of heavy metals, industrial and DOE facility processes, nondestructive analysis, photonic band gaps, quasicrystals, sensing devices, instrumentation for genomic mapping, and others.

Established in 1981, the **Materials Preparation Center (MPC)** is supported by the Materials Sciences Branch of the Department's Office of Science. The Center is recognized for its unique capabilities in the preparation, purification, and characterization of rare-earth, alkaline-earth, and refractory metal materials for preparing ultra high-purity and well-characterized metals, alloys, compounds, and single crystals. The Center makes these materials available to other Department Laboratories, to other agencies, to universities, and to the private sector, and yearly satisfies hundreds of requests for customized materials and services that are unavailable from commercial suppliers and unmatched in quality anywhere else in the world.

In addition, the Materials Referral System and Hotline (MRSH) provides access to information on materials gathered from more than 2,000 companies nationwide, the Rare-earth Information Center (RIC), established at the Ames Laboratory by the U.S. Atomic Energy Commission's Division of Technical Information in January of 1966 and now transferred to Iowa State University serves the scientific and technological communities by collecting, storing, evaluating, and disseminating rare-earth information from various sources.

The Scalable Computing Laboratory focuses on parallel computing, and on software, hardware, and management research in the construction and use of inexpensive clusters of PC computers to achieve supercomputing performance.

Funding by Activity

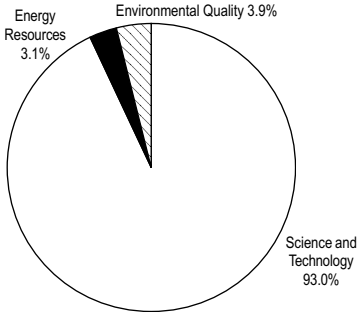


Note: No Construction funding for Ames in 1996-99. No External Performers in 1996-98.

Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

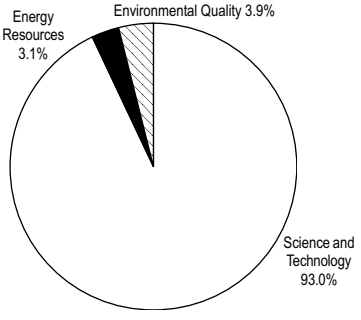
Funding by Mission Area

R&D Funding by Mission Area Total: $22.8 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $23.5 million



Note: Mission Footprint excludes remediation funds.

Ames Laboratory

Key Research and Development Activities

Science and Technology Mission

Ames Laboratory contributes to the Department's Science and Technology mission in the areas of basic energy sciences, and advanced computing and technology research in support of science. Its work also supports fossil energy and energy efficiency research, particularly renewable energy research, and the development of methodology and analytical tools for expedited site characterization for use in the environmental cleanup and forensic applications.

In the area of materials science, Ames scientists focus on synthesis and processing of rare-earth materials with unique purity, crystal structure and desirability, and to finding new synthetic routes to known and unknown materials including metastable oxides, nitrides and silicides of metals, silicon-based polymers, metal oxide electrocatalysts and fluorocarbons. Other focuses include the synthesis, characterization and modeling of new materials. High-Tc superconductors, fullerenes, and magneto-optic materials are the focal point for new synthesis methods and for characterization measurements. Ames is now the center of quasicrystal research in the U.S. and quasicrystal samples made at Ames are being used for experiments throughout the world. Scientific initiatives include the development of a novel, high pressure gas atomization process that employs powder metallurgical methods to produce a variety of materials from high-strength/high-conductivity alloys to lightweight structural composites and permanent magnet materials. The design and demonstration of photonic band gap crystals: materials that would make it easier to develop numerous practical devices, including optical lasers and computers, and solar cells. The Laboratory has the facilities to allow scientists to study the high-temperature crystal structures of new superconductors, intermetallic alloys, magnets, and ceramics, thus providing the insight needed to develop and modify processing techniques for the microstructuring of new materials. Theorists at the Lab are leaders in modeling large molecular systems with the aid of advanced parallel computers. Theoretical research in condensed matter physics includes studies of phase transitions, spin dynamics, and the effects of disorder in crystals, alloys and glass. They are among the leading international groups for research in photonic bandgap materials.

In chemical sciences, researchers are studying the chemical kinetics and reactivity of transition metal complexes, new synthetic routes to inorganic catalytic materials using organometallic precursors and molecular "stepping stones," spectroscopic and kinetic characterization of metal oxide catalysts, spectroscopic and phenomenological studies of catalysts and advanced materials, organometallic complexes in homogeneous catalysis, analytical separations, analytical spectroscopy, lasers in analytical chemistry and chemical analysis at liquid-solid interfaces. Other research is elucidating the fundamental processes in biological solar energy conversion with application to development of new solar energy technologies, and the explanation of the structure, energetics and dynamics of chemically reactive systems in terms of their fundamental atomic, molecular and electronic constituents.

Other ongoing research includes application of parallel computers to various scientific and engineering problems; advanced computer architecture performance; techniques to substantially increase the speed, throughput, reliability and sensitivity in DNA sequencing applications in highly multiplexed capillaries; instrumentation, such as, monitoring air toxics, detecting trace elements in solid materials, new or improved non-destructive evaluation techniques, the development of Virtual Power Plants, developing laser-based technologies for the study of biological insult from environmental chemical carcinogens, and designing prototypes of novel micropatterned biodegradeable polymeric guidance conduits to achieve directional peripheral nerve regeneration.

A user facility, the Materials Preparation Center, was developed to help scientists worldwide access high-quality materials and specialized materials services for specific research needs. The Center provides expertise in preparing the purest forms of many materials.

Significant Accomplishments

The Second Hardest Bulk Substance after Diamond (1999): Ames scientists developed a new boron-aluminum-magnesium (BAM) compound that tests confirm is the second hardest bulk substance after diamond.

Spin Dynamics (1995–ongoing): Allows spin polarized solution of Schrodinger equation at finite temperature with non-collinear spin configurations. Is being applied to study magnetic interactions near defects to establish pinning forces for domain wall motion in permanent magnets.

Homogeneous Catalysts Tethered to Solid Supports (ongoing): A new class of materials that combine the best aspects of homogeneous and heterogeneous catalysts.

Electrochemical Degradation of Wastes (ongoing): Ames researchers have developed electrolytic processes that can incinerate chemical wastes.

Synthesis and Characterization of Novel Superconductors (1994): RNi2B2C magnetic superconductors were discovered in January 1994. By March 1994, Ames researchers had devised a method for the synthesis of large single crystals for R=Gd-Lu.

Cluster Computing and System Performance Tests for Clusters (1989–ongoing): The evaluation techniques and application of tight binding molecular dynamics to advanced materials simulations using supercomputers.

Quasicrystals (ongoing): Quasicrystals constitute a new form of solid matter which is now being exploited in cookware, electric shavers and surgical tools. The Laboratory's samples are in demand worldwide.

Cancer Detection Using Capillary Electrophoresis-Fluorescence Line-Narrowing Spectroscopy (CE-FLNS) (ongoing): An on-line technique, CE-FLNS, which can provide more detailed information on complex biomolecular samples. The reseach led to the discovery of a new pathway that chemical carcinogens take for their attack on DNA.

K-edge Heavy Metal Detector (1997–ongoing): The detector can precisely identify contaminated materials and measure contaminants within an accuracy of 10%. The K-edge detector surpasses other measurement techniques by providing nondestructive in-situ analyses.

New Ternary Molybdenum Sulfide Cluster Compounds and Their Activity as Hydrodesulfurization Catalysts (1995–1998): A new family of compounds was discovered and prepared as amorphous materials with high surface areas. An application of these anodic oxygen-transfer reactions is in toxic organic wastes which will be oxidatively degraded to non-toxic forms that can be discharged safely to the environment.

Multiplex Multifluor DNA Sequencer (1994–ongoing): This technology rapidly sequences different portions of the genome simultaneously while reducing the costs of gathering this information.

Resonant and Nonresonant Magnetic Xray Scattering (1994–ongoing): Ames has demonstrated and developed practical techniques for ab-initio magnetic structure determinations that provide an important co\mplement to traditional neutron diffraction methods.

Magnetic Refrigeration (1994–ongoing): Ames scientists have developed a highly efficient magnetocaloric material that makes magnetic refrigeration technology efficient enough to cheaply produce liquid hydrogen, very likely one of the first major commercial uses of magnetic refrigerators.

Lead-Free Solder (1992-1996): Ames has developed a lead-free alloy for use in strong, high performance solder pastes.

3-D Photonic Band Gap Materials (1991–ongoing): Ames is internationally recognized as one of the creators of the new field of photonic band gap (PBG) materials. Besides initial breakthroughs, Ames has obtained the highest frequency 3D photonic band gaps to be manufactured today.

Inductively Coupled Plasma (ICP) Technique for Chemical Analysis (1970s): Ames pioneered the conception and development of ICP, which enables the rapid and accurate determination of up to 70 elements in metals, alloys and organic compounds such as oil, serum, blood and soils.

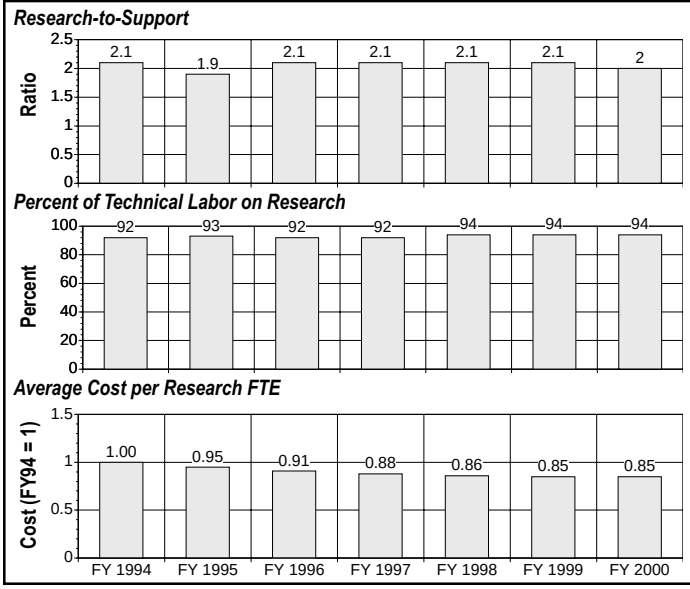
Synthesis and Processing of Highest Purity Metals and Alloys and the First Purification and Characterization of the Rare Earth Metals (1950s).

Ames Laboratory

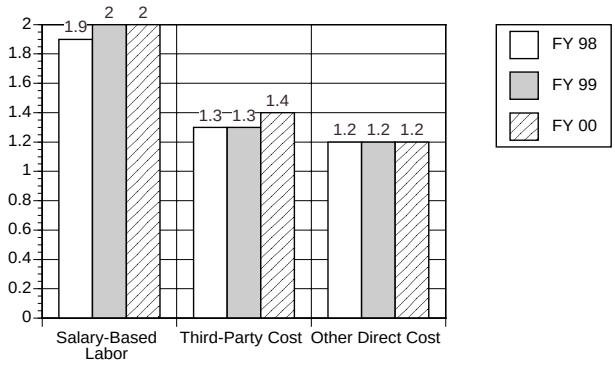
Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

Category/Mission	Partner	Description
Science and Technology—in the areas of basic energy sciences, advanced computing and technology research in support of physics and other DOE programs, energy efficiency research (particularly renewable energy research), and methodology and analytical tools for expedited site characterization for use in the environmental cleanup of the DOE complex . Ames' partnerships and collaborations build upon the fundamental science performed within the various research programs at the Laboratory. The uniqueness of Ames' (located on the campus of Iowa State University and many of Ames' researchers hold faculty positions at ISU) contributes substantially to the formation of various basic and applied research collaborations and partnerships.	Anval	Fabrication and application testing of modified HPGA-III atomization nozzles.
	Arizona State University	Light harvesting complexes. Study of green bacterial systems.
	Astronautics Corp. of America; Altas Scientific	Magnetocaloric materials for magnetic refrigeration applications.
	Chubu Electric Power Co., Inc.	Degradation of gas turbine blade coating.
	FBI	Laser ablation ICP-MS.
	Ford, GM, Chrysler	New light weight materials.
	IBM	Cluster development. Access to a new high-speed proprietary System Area Network fabric.
	Jet Propulsion Lab	Additional prepation of cryocooler metal hydride sorbent, LaNi*4.8*Sn*0.2*
	F. Z. Jeulich	MuCAT Beamline at APS.
	Lawrence Berkley National Laboratory (LBNL)	Development of techniques and protocols for trace levels elemental characterization of metal fragments and other solids by laser ablation. Heat capacity measurements. Development for the mVIA package.
	Massachusetts Institute of Technology	Development of the processing science of Ni-Ga-Mn alloys.
	Moscow State University	Basic studies of rare earth materials and the magnetocaloric effect. Researchers work on magnetic refrigeration and magnetocaloric materials.
	National Aeronautics and Space Administration (NASA)	Help investigate the dynamic evolution of interface patterns during directional solidification. Collaborative studies in solidification microstructures. Processing optimization of Dy-Zn magnetostrictive alloys. Develop a miniaturized liquid chromotograph.
	National Institute of Health	Miniaturization of DNA sample preparation on electrophoresis and to develop cancer diagnostic schemes based on single-moledule imaging.
	Siecor	On-line monitoring of cure of glass.
	University of Glasglow	Light harvesting complexes.
	University of Illinois	Newly established CSP project on a Design and Synthesis of Ultrahigh-Temperature Intermetallics foxuses on Mo*5*Si*3*B-based materials. Two-Magnon Raman scattering.
	University of Missouri	Rare earth materials.
	University of Utah	Electrocptic polymers. Accurate measurements of binding energiess of metal ions to various substrates.

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Fermi National Accelerator Laboratory

Laboratory Information

Location: Batavia, Illinois
Number of Full-Time Equivalent Employees: 2,231
Scientific and Technical Degrees: 1,178
Contractor: Universities Research Association, Inc.
Accountable Program Office: Science
Field Office: Chicago Operations Office
Web Site: http://www.fnal.gov

Funding Sources

Science: $296.9 million
Nuclear Energy:
Energy Efficiency and Renewable Energy:
Environmental Management:
National Security and Nonproliferation:
Fossil Energy:
Other DOE: $0.1 million
Non-DOE: $1.9 million

Total Funding: $297.1 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

Fermi National Accelerator Laboratory was founded in 1967 as a national laboratory to lead the nation in the exploration of the fundamental nature of matter, using high-energy proton beams to probe subatomic structure at the smallest scale. Today, Fermilab operates the Tevatron, the world's first superconducting synchrotron creating proton-antiproton collisions with the highest energy of all the "high-energy" physics labs in the world. It is the nation's largest and most active user facility in particle physics, with 2,500 scientific users from 34 states and 25 countries. Fermilab's mission remains what it has been from its founding: to advance the understanding of the fundamental nature of matter and energy by providing leadership and resources for qualified research at the frontiers of high-energy physics and related disciplines.

Distinctive Competencies and Major Facilities

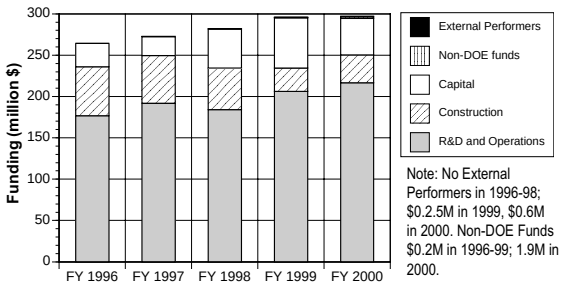
Fermilab leads the nation in the construction and operation of large facilities for particle physics research, and in the underlying technology for high-energy physics research. Capabilities include:

– Operation of the world's highest-energy user facility for research into the fundamental structure of matter by university scientists.
– Accelerator research, design and development of the frontier machines that are necessary to keep the U.S. among world leaders in high-energy physics.
– Magnet research, design and development with particular emphasis on and expertise in leading-edge superconducting magnet technology.
– Detector design and development for the detection and recording of trillions of high-energy particle collisions.
– High-performance computing and networking to support high-energy physics in online data-taking, storage, analysis and world-wide data sharing and physics collaboration. (The World Wide Web was born from this last requirement.)
– International scientific collaboration, both at Fermilab and as a contributor to foreign laboratories such as CERN.
– Construction and management of large scientific and technical projects, including the $260M Main Injector accelerator, now being completed on time and on budget.
– Scientific education of graduate students and additional science education programs for undergraduates and K-12.

Major user facilities:

– The Tevatron, the world's most powerful particle accelerator, creating high-energy proton-antiproton collisions and proton beams.
– The Antiproton Source, the largest supply of antimatter in the world, used for proton-antiproton collisions and research on antimatter.
– Two large collider detectors, CDF and DZero. Each serves an international collaboration of 500 + university physicists.
– Fixed-target experiments, including the NuMI project, now under construction, to explore the question of neutrino mass.

Funding by Activity

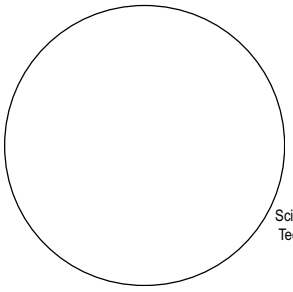


Note: No External Performers in 1996-98; $0.2.5M in 1999, $0.6M in 2000. Non-DOE Funds $0.2M in 1996-99; 1.9M in 2000.

Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

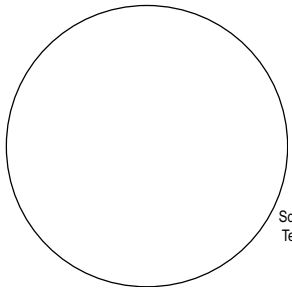
Funding by Mission Area

R&D Funding by Mission Area Total: $297.1 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $297.1 million



Note: Mission Footprint excludes remediation funds.

Fermi National Accelerator Laboratory

Key Research and Development Activities

Science and Technology Mission

Fermilab provides the capability for the U.S. to remain a world leader at the frontiers of the science of particle physics. Together with Stanford Linear Accelerator Center, Fermilab provides U.S. scientists with the accelerators, detectors, computing and support facilities needed to carry out research at the forefront of high-energy physics.

Key R&D activities include:

– Experimental particle physics research into the fundamental structure of matter;

– Accelerator physics research, to conceive, design and build the physics research tools of the future;

– Particle physics theory;

– Experimental and theoretical particle astrophysics, to exploit the convergence of particle physics and cosmology;

– Science education, to train the next generation of particle physicists and to increase the nation's science literacy.

– In 2000, Fermilab provided 2,506 university scientists from 34 states and 25 countries with the opportunity to work at the high-energy frontier, the Tevatron particle accelerator. Of Fermilab users, roughly half are funded by the Department, one tenth by the National Science Foundation, and the remainder by foreign funding sources.

Significant Accomplishments

Discoveries made at Fermilab in the three decades of its operation have played a significant role in characterizing the current understanding of the fundamental structure and nature of matter.

Tau neutrino observed: On September 21, 2000, Fermilab scientists announced the first direct observation of the tau neutrino, the last unobserved particle of the Standard Model of Particles and Forces.

CP violation: In February 1999, Fermilab scientists announced the observation of the first signs of matter-antimatter asymmetry in the physics of subatomic particles called b quarks.

Time Reversal Symmetry Violation: In October 1998, Fermilab scientists announced the direct observation of time reversal symmetry violation in rare kaon decays.

Discovery of B_c Meson: In March 1998, Fermilab scientists announced the discovery of the last of the mesons, the B_c, a combination of bottom and charm quarks.

Top Quark Discovery: In March 1995, Fermilab scientists announced the discovery of the top quark, the last of the fundamental building blocks of matter in the Standard Model.

Science Education: In September 1992, Fermilab dedicated the Lederman Science Education Center to house its award-winning education program.

Proton-Antiproton Collisions: In 1985, Fermilab scientists observed the first proton-antiproton collisions at 1.6 TeV center-of-mass energy in the Tevatron.

Bottom Quark Discovery: The third generation of quarks was born at Fermilab with the discovery of the bottom quark in June 1977.

Beam Energy Doubled: On December 14, 1972, the energy of the Main Ring proton beam reached 400 GeV.

Proton Beam: On March 1, 1972, Fermilab first accelerated 200 GeV protons through the original accelerator, the Main Ring.

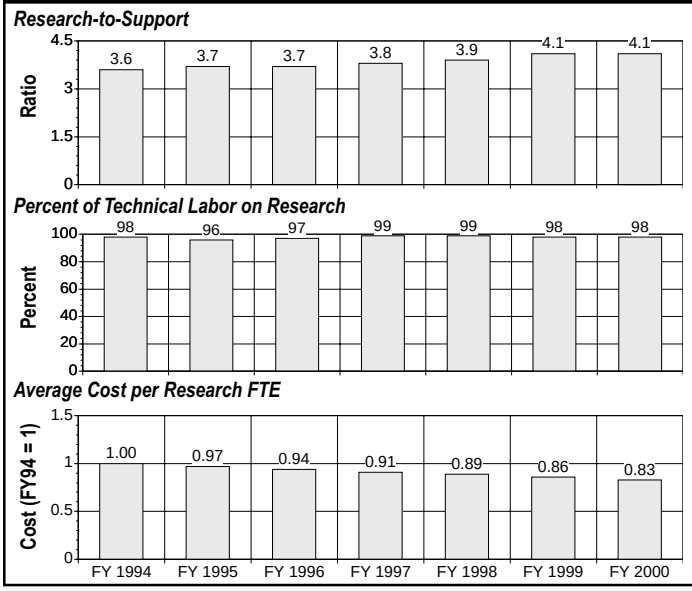
Fermi National Accelerator Laboratory

Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

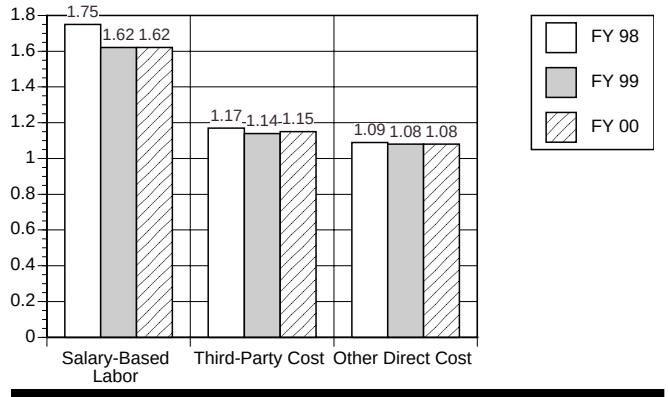
Partnerships and collaborations with university scientists are the essence of Fermilab's purpose for being.

Category/Mission	*Partner*	*Description*
Science & Technology	Universities	Fermilab is operated by Universities Research Association, Inc., a consortium of 89 research universitiesin the U.S, Europe, Canada and Japan. Fermilab collaborates with four universities in the Sloan Digital Sky Survey, an astro collaboration. Fermilab collaborates with universities from 18 countries in the Pierre Project, a collaboration to study cosmic rays. Fermilab collaborates with four universities and other consortiums and institutes in the Sloan Digital Sky Survey, an astrophysics collaboration. Fermilab collaborates with universities from 18 countries in the Pierre Auger Project, a collaboration to study cosmic rays.
	Other DOE Laboratories and Facilities	Fermilab's users include scientists from Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley National Laboratory, Los Alamos National Laboratory and Lawrence Livermore National Laboratory.
	International	Of Fermilab's 2,506 users, 923 come from 116 institutions in 25 foreign countries. Fermilab is playing a leading role in the U.S. effort for the Large Hadron Collider at CERN, both for the LHC accelerator and for the Compact Muon Soleniod (CMS), one of two major detectors. Fermilab is a member of the Pierre Auger Project, a cosmic ray collaboration with membership from 18 countries. The Sloan Digital Sky Survey, the MINOS collaboration, and the Cold Dark Matter Search are all international collaborations

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

National Energy Technology Laboratory

Laboratory Information

Location: Morgantown, West Virginia, Pittsburgh, Pennsylvania, and Tulsa, Oklahoma
Number of Full-Time Equivalent Employees: 550 Federal & 600 Contractor
Scientific and Technical Degrees: 400 Federal & 300 Contractor
Contractor: Government owned and operated
Accountable Program Office: Fossil Energy
Field Office: Laboratory and Operations Office combined
Web Site: http://www.netl.doe.gov

Funding Sources

Science:
Nuclear Energy: $0.1 million
Energy Efficiency and Renewable Energy: $46.2 million
Environmental Management: $77.2 million
National Security and Nonproliferation: $3.7 million
Fossil Energy: $299.9 million
Other DOE: $13.9 million
Non-DOE: $36.2 million

Total Funding: $477.2 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

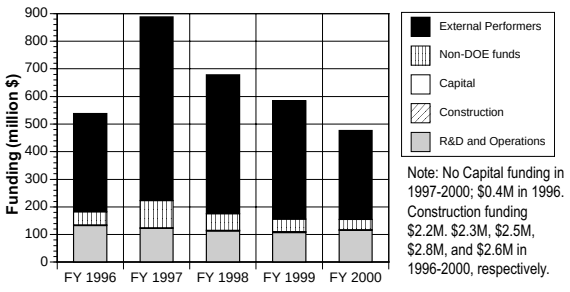
Description

The newly designated as a national laboratories, yet with 50 years fossil R&D experience, our primary mission is to assure that U.S. fossil energy resources (coal, natural gas, and oil) meet increasing demand for affordable energy without compromising quality of life. NETL has three locations in PA, WV and OK (National Petroleum Technology Office) integrated in a matrixed operational structure. In adddition to Fossil R&D our mission to include support to the development and deployment of environmental technologies for cleaning up the DOE's weapons complex. Our laboratory is federally operated and we place emphasis on partnering with industrial, academic, and other governmental stakeholders in over 900 RD&D projects to create commercially viable technical solutions to energy and environmental problems.

Distinctive Competencies and Major Facilities

The Laboratory's distinctive capabilities include expertise in fossil energy technologies, growing experience in nuclear cleanup, contracting and project management capabilities, focus on product development, and cradle-to-grave assessment capability. Major on-site and off-site facilities include: **Combustion and Environmental Research:** Measures fuel, emissions, & efficiency performance addressing fuel handling, combustibility, ash deposition, & flue gas emissions issues. **Gas Process Development Unit:** Fills gap between small-scale testing and large-scale demonstration. Operates both as fluid-bed reactor and a transport reactor. Modular Gas Cleanup Rig and Fluid Bed Gasifier:Jetting fluidized-bed gasifier provides fuel gas for testing and developing high-temperature, high-pressure components and processes in reducing and oxidizing environments. **Solids Processing Research:** One-of-a-kind, state-of-the-art facility for solids processing technologies with capability to handle 500 to 2500 lb/hr continuous feed. **Life Cycle Test:** Evaluats various dry, regenerable sorbent flue-gas-cleanup processes in a continuous mode of operation, and sampling techniques for the measurement of air toxics. **Power Systems Development:** The Nation's first large scale, modular test center for 21st century power technologies. **Clean Environmental Development:** A 100 million Btu/hr (10 MWe) facility provides engineering and performance data on conventional and advanced emissions control technologies. Others: **High Temperature Gas-Stream Cleanup Test , Circulating Fluidized-Bed Cold Model, Computational and Simulation, Science and Analytical Instrumental Laboratories, Dynamic Gas Turbine, the Low-Emmissions Combustion Test & Research, & High Pressure Water Tunnel.**

Funding by Activity

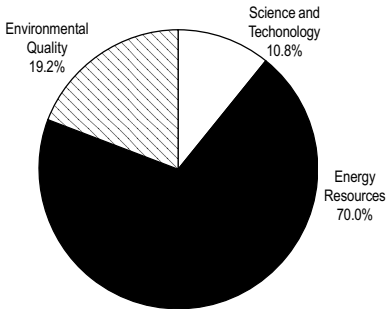


Note: No Capital funding in 1997-2000; $0.4M in 1996. Construction funding $2.2M. $2.3M, $2.5M, $2.8M, and $2.6M in 1996-2000, respectively.

Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

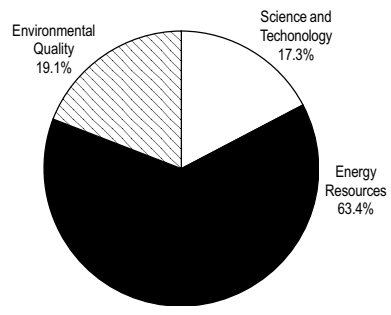
Funding by Mission Area

R&D Funding by Mission Area Total: $428.7 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $477.2 million



Note: Mission Footprint excludes remediation funds.

National Energy Technology Laboratory

Key Research and Development Activities

Energy Resources Mission

The Laboratory is the largest fossil energy research and development facility in the nation. Its focus is research and development in the area of fossil energy technologies that are efficient, cost effective, and environmentally friendly. **Advanced Power Generation Systems**: Includes both coal- (innovative combustion and gasification processes) and natural-gas-fueled (advanced turbines and fuel cells) electric power generating systems. **Advanced Fuel Technology**: Producing high-quality, clean-burning transportation fuels from oil, natural gas and coal that reduce particulates, NOx, and hydrocarbon emissions. **Advanced Research and Environmental Technologies**: R&D to meet tighter environmental standards to mitigate concerns over ambient levels of ozone and fine particulates from coal and techniques for sequestering CO2. **Natural Gas Exploration Production and Distribution**: R&D to the capture methane, a greenhouse gas, from coal mines prior to mining, maintaining and enhancing the integrity and reliability of the natural gas distribution and transmission systems, in materials, tools and operations that will be needed to maintain infrastructure & meet future system demands.

Environmental Quality

NETL provides scientific, engineering and business management expertise to address environmental quality problems within the DOE Weapons Complex. NETL develops, demonstrates and assists the deployment of innovative environmental management technologies to lower the cost and risk and to accelerate the schedule for cleanup of the DOE Weapons Complex. While addressing all environmental remediation and waste management problems, special emphasis is placed on improved technologies for decontamination and decommissioning of nuclear facilities. NETL utilitizes the entire community of science, including universities, private industry and government laboratories, both domestic and international. New technical solutions are brought to the commercial marketplace through an industry-oriented model that has application to the nation's cleanup activities.

Significant Accomplishments

Fossil Energy: High Efficiency Performance Power System (HiPPS) project set a record for a radiant air heater at 2000º F, implying that coal plants with 55% efficiency are possible. Low Emissions Boiler System (LEBS) project demonstarted emissions at less than one-sixth of federal New Source Performance Standards. Fuel Cells projects field tested the world's largest solid-oxide fuel cell electric generator. Advanced Turbine Systems resulted in advanced compressors exceeded design targets for efficiency and performance critical in the development of a new generation of super-efficient utility gas turbines. Secondary gas recovery R&D methods lead to extracting a greater fraction of gas in each field resulting in an incremental increase in gas production and an estimated savings of $70 million. Development of a methodology that integrates advanced geological and geophysical technologies for identifying natural fracture systems in tight gas formations that has increased the success rate of finding producible gas four fold and the addition of 1 Tcf of new, low-cost gas reserves.

Environmental Management: D&D of Nuclear Facilities: 85 technologies demonstrated and validated; 55 of these were deployed a total of 200 times; broad application across the DOE Weapons Complex will reduce EM cleanup costs and mortgage by $1.5 billion. Technologies include: oxygasoline torch; personal ice cooling system. Environmental Remediation/Waste Management: 76 technologies demonstrated and validated; 23 of these were deployed a total of 48 times; Technologies include: robotic end effector for inspection of HLW storage tanks; prefabricated vertical drains to clean contaminated soil and groundwater.

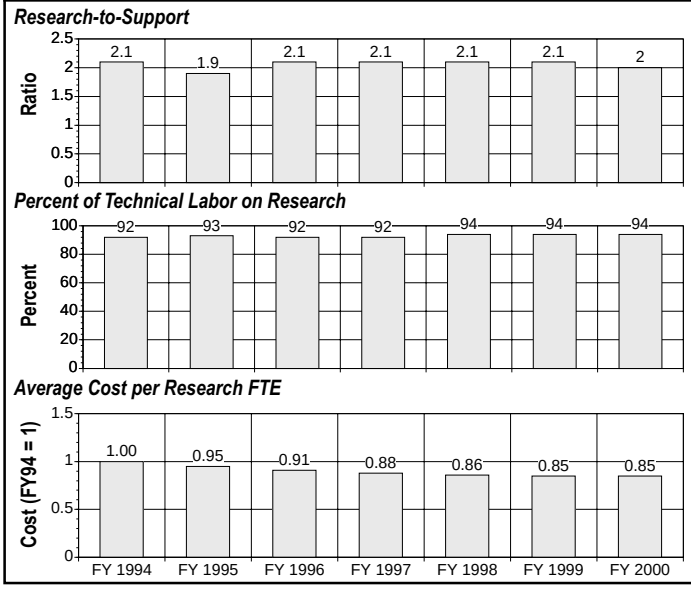
Awards and Recognition: Five Clean Coal Technology demonstration projects among the first inductees into the Power Plant Hall of Fame (www.MyPlant.com) R&D-100 Award for RVS-1 Desulfurization Sorbent is a durable, regenerable, and efficient pelletized material used to clean gaseous sulfur from raw, high-temperature fuel gas in coal plants allowing improved energy efficiency & avoids sulfur pollutant emissions. The National Petroleum Technology Office is reorganized into the NETL fold to bring gas, coal and oil under one research umbrella. The Strategic Center for Natural Gas was created at NETL by Secretary Richardson provide a focal point within the Federal government to look out for the future of natural gas "from borehole to burnertip."

National Energy Technology Laboratory

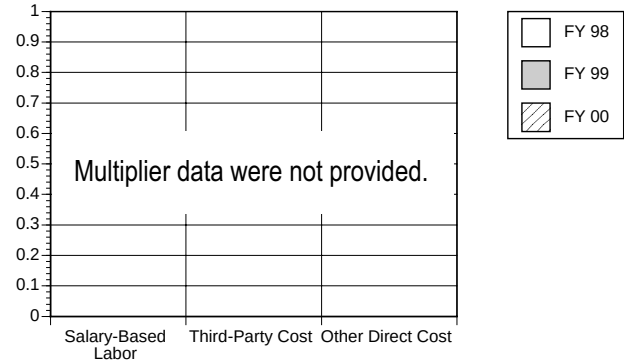
Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

Category/Mission	Partner	Description
Energy Resources	Southern Company Services, Inc	The Power Systems Development Facility project which consists of four technology clusters for systems and component testing.
	General Electric Company	An Advanced Turbine System (ATS) project which develops & demonstrates a highly efficient, environmentally superior, and cost competitive utility ATS.
	Foster Wheeler Development Corp.	A High Performance Power System project which is a coal-fired combined-cycle system that links a high-efficiency gas turbine cycle with a steam turbine cycle.
	CPICOR Management Company	Clean power from integrated coal/ore reduction.
	Siemens-Westing-house Power Corporation	An Advanced Turbine System (ATS) project which develops & demonstrates a highly efficient, environmentally superior, and cost competitive utility ATS.
	Fuel Cell Energy	This project involves developing and demonstrating a full scale fuel cell power plant that is highly efficient, environmentally superior and cost competitive.
	United Technologies Research Center	This project involves development of an innovative, clean and efficient coal-fired power plant for the 21st century (a High Performance Power System).
	Air Products & Chemicals, Inc.	Project demonstrates the production of methanol and co-production of methanol and dimethyl ether from coal-derived synthesis gas.
	U of ND Energy & Envir. Research Center	Various projects which support NETL's advanced research and environmental technologies program.
	Energy & Environ-mental Solutions	Managing multiple projects and tasks that support NETL's energy and environmental programs.
	Air Products Liquid Phase Conversation	A commercial scale demonstration of liquid phase methanol.
	Oak Ridge National Laboratory	Managing numerous advanced research and technology development agreements in energy and environmental programs.
	Agency for International Development	Managing international activities in India and Egypt and others to promote and deploy fossil energy technologies.
	Various Industry and Governmental Partners	Providing key technical leadership and participation for New Business Development activities.
	Various Industry Partners	Managing multiple Clean Coal Technology cooperative agreements with various electric utilities, technology vendors, and industrial organizations.
	Various Industry Partners	Managing numerous agreements with industry to jointly fund and manage R&D projects in the power systems and advanced fuel technology areas.
	Various Industry and Government Partners	Managing numerous agreements with industry, academia, and government to jointly fund and manage R&D projects under the Strategic Center for Natural Gas.
Environmental Quality	Various Industry Partners	Managing numerous agreements with industry to jointly fund and manage R&D projects in technology development for environmental management.

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

National Renewable Energy Laboratory

Laboratory Information

Location: Golden, Colorado
Number of Full-Time Equivalent Employees: 822
Scientific and Technical Degrees: 439
Contractor: Midwest Research Institute
Accountable Program Office: Energy Efficiency and Renewable Energy
Field Office: Golden Field Office
Web Site: http://www.nrel.gov

Funding Sources

Science: $5.4 million
Nuclear Energy:
Energy Efficiency and Renewable Energy: $175.0 million
Environmental Management: $0.1 million
National Security and Nonproliferation: $1.0 million
Fossil Energy: $0.1 million
Other DOE: $0.1 million
Non-DOE: $4.8 million

Total Funding: $186.5 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

The National Renewable Energy Laboratory (NREL) was established by the Solar Energy Research, Development and Demonstration Act of 1974 as a national center for federally sponsored solar energy research and development. Its mission is to lead the nation toward a sustainable energy future by developing renewable energy technologies, improving energy efficiency, advancing related science and engineering, and facilitating commercialization. NREL is the world leader in developing renewable energy technologies and a primary laboratory for developing energy efficiency technologies. As a Federally Funded Research and Development Center (FFRDC), NREL is a strategic advisor and partner with DOE, assisting DOE with the full range of activities from research and development through technology demonstration to facilitating deployment of these technologies into global markets. From its inception, the National Renewable Energy Laboratory has relied on industrial and academic partnerships to achieve its mission, purposefully subcontracting about half of the its funding to universities, small and large businesses, and non-government agencies.

Distinctive Competencies and Major Facilities

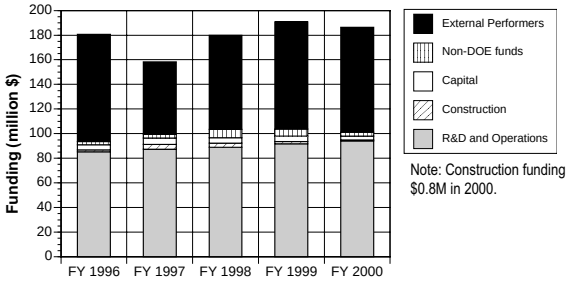
Distinctive Competencies

— Fundamental science related to renewable energy and energy efficiency technologies.
— Development and characterization of renewable energy, energy efficiency, and industrial conversion processes and technologies
— Systems and process engineering and integration for renewable energy and energy efficiency technologies
— Integration of efficiency and renewable technologies with conventional fuel supply sources.
— Clean energy analysis.
— Establishing partnerships for market and technology development for renewables and energy efficiency technologies.

Major Facilities

— **National Wind Technology Center:** 280-acre facility to develop and test wind turbines; outdoor test pads; certification laboratoires; Industrial User Facility, Advanced Research Turbine Facility; Hybrid Power Test Facility
— **National Center for Photovoltaics:** Solar Energy Research Facility containing laboratories for research in photovoltaics, superconductivity, related materials science; an energy-efficient design showcase using 36% less electricity than the federal standard; won numerous architectural awards. Outdoor Test Facility (outdoor testing of modules and other components)
— **National Bioenergy Center:** Alternative Fuels User Facility containing laboratories and large-scale (1 ton/day) fermentation pilot plant to produce ethanol from biomass. Thermochemical User Facility for industrial process research in pyrolysis and gasification.
Field Test Laboratory Building, containing laboratories for chemistry, biochemistry, photochemistry, photobiology, and related research.
— **Thermal Test Facility:** Building research activities; the building itself uses 60%-70% less energy than the federal standard; won numerous architectural awards.

Funding by Activity

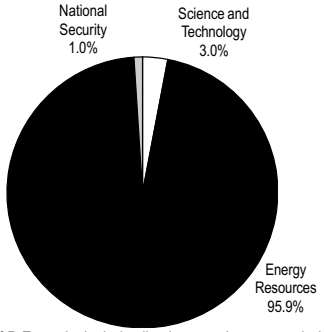


Note: Construction funding $0.8M in 2000.

Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

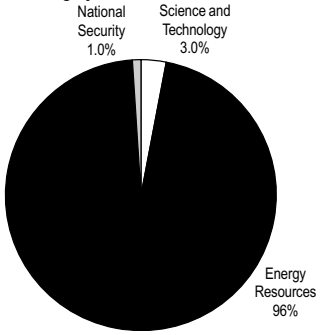
Funding by Mission Area

R&D Funding by Mission Area Total: $177.3 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $186.4 million



Note: Mission Footprint excludes remediation funds.

National Renewable Energy Laboratory

Key Research and Development Activities

Energy Resources Mission: The Laboratory's primary focus is renewable energy and energy efficiency technology development, which is a key element of the Comprehensive National Energy Strategy, the DOE Strategic Plan, and the DOE Energy Resources R&D Portfolio. The Laboratory's knowledge complements other labs in many areas. For example: its biomass conversion expertise complements Oak Ridge National Laboratory's biomass resource development; its photovoltaic materials, devices, modules, and processing knowledge complements Sandia National Laboratory's balance of systems engineering for photovoltaics; its whole building energy efficiency focus complements Lawrence Berkeley National Laboratory's window and lighting technology. Specific R&D activities include:

- Photovoltaic Energy
- Wind Energy
- Concentrating Solar Power
- Solar Heat and Buildings
- Geothermal Energy Conversion
- Hydrogen Production and Storage
- Biomass Power
- Biofuels
- Alternative Fuels Utilization
- Advanced Vehicles
- Renewable Energy Resource Assessment and Characterization
- Building Energy
- Advanced Industrial Technologies
- Analysis related to Renewable Energy and Energy Efficiency
- Federal Energy Management Program
- International Renewable Energy Project Management
- State and Local Government Energy Initiatives
- Technical Information for Renewable Energy and Energy Efficiency

Activities that integrate across renewable energy technologies are important for the success of all technologies. The Laboratory has developed extensive solar and wind data and information, used by organizations around the world through online databases, and has advanced resource assessment methodology, instrumentation, and modeling using geographic information systems. NREL has a substantial economic and market analysis capability for renewables, as well as being the national focal point for information about renewable energy and energy efficiency and DOE's programs in this area. NREL is pursuing opportunities for developing hybrids of renewable energy and fossil energy systems to take advantage of the best characteristics of both. NREL is also helping DOE to develop a new research program in distributed energy, examining issues that pertain to all distributed generation technologies such as interconnection standards.

Science and Technology Mission: The Laboratory is recognized nationally and internationally for its fundamental research underpinning renewable energy technologies: photoconversion and artifical photosynthesis; electrochemistry; catalyst design and synthesis; semiconductor theory, physics, and growth; high-temperature superconductivity; yeast, fungus, and enzyme microbiology and genetic engineering.

Energy Security Mission: Initiatives for Proliferation Prevention (renewables development in former Soviet Union), thermophotovoltaics for specialty power sources.

Significant Accomplishments

Cold-climate Wind Turbine: NREL and Northern Power Systems of Vermont developed a state-of-the-art medium-sized wind turbine specifically designed for operation in remote, cold-climate conditions. Expected uses are Antacrctic research stations, Mars exploration, and remote towns and villages in northern Alaska. (R&D 100 and R&D Editors Award 2000)

Real-Time Biomass Analysis: NREL worked with major paper and forestry companies to develop a new technique to use infrared spectroscopy to characterize wood, wood products, and plant materials to determine their chemical and mechanical properties and value to industry. The analyses can be done in the field, in the forest, or at the plant. (R&D 100 Award 2000)

Electroexploded Metal Nanopowders: NREL developed a technology to make ultrafine particles of aluminum and other metals much smaller and much less expensively thatn previously available. The greater reactivity of ultrafine particles makes them valuable for improved lubricants, catalysts, coatings, inks, and rocket fuels. A Florida company is producing and selling the nanopowders. (R&D 100 Award 2000)

Advanced Direct Contact Condenser: NREL worked with industry and utility partners to develop this condenser which increases the efficiency (5%) and production capacity (17%) and reduces the pollution of geothermal power plants. (Federal Laboratory Consortium Award 2000, R&D 100 Award 1999)

High-Performance Thin Film PV: NREL assisted Siemens Solar Industries in developing and commercializing photovoltaic modules using copper indium diselenide thin films with sunlight-to-electricity conversion efficiencies of about 10%, the highest of any commercial non-crystalline module. (R&D 100 Award 1999)

Hydrogen-Producing Photobiological Algal System: NREL in collaboration with the University of California at Berkeley discovered a cyclic photobiological laboratory-scale process that for the first time produces pure, bulk hydrogen gas from water using green algae, triggering extensive interest in the scientific and popular press. (2000)

Cleaner Diesel Fuels and Advanced Natural Gas Engines for Heavy-Duty Vehicles: NREL managed the testing of a new diesel fuel and catalyzed particle filters that has resulted in 91%-99% less particulate matter being emitted from vehicles, and the commercialization of British Petroleum's first ultra-low sulfur diesel fuel. Also, NREL assisted industry in developing advanced natural gas heavy-duty engines for trucks and buses, leading to the deployment of two new engines, one with the highest horsepower of any dedicated natural gas engine on the market. (2000)

Reducing Energy Use in Buildings: NREL assisted the building industry in completing more than 1500 houses as part of the Building America project in 1999 and 2000, where climate-appropriate combinations of high-performance building envelope and equipment systems were optimized with NREL engineering assistance. The new houses perform 30%-75% better in terms of energy, thermal properties, and air tightness than conventional houses. (1999-2000)

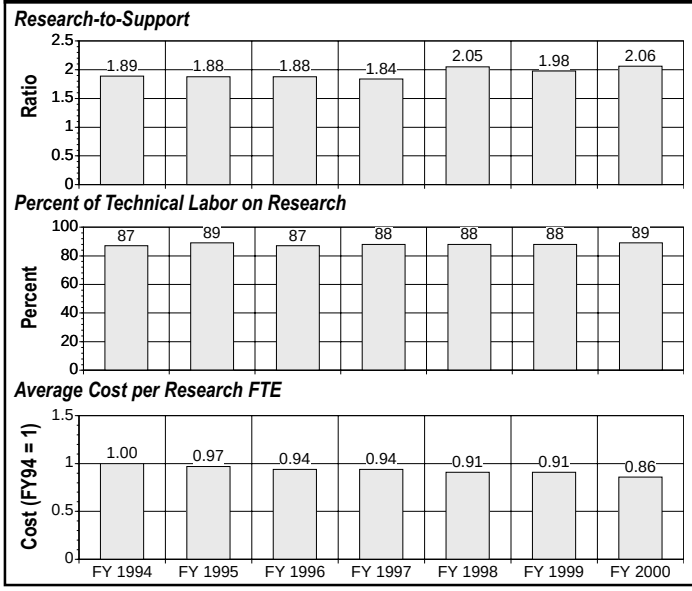
National Renewable Energy Laboratory

Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

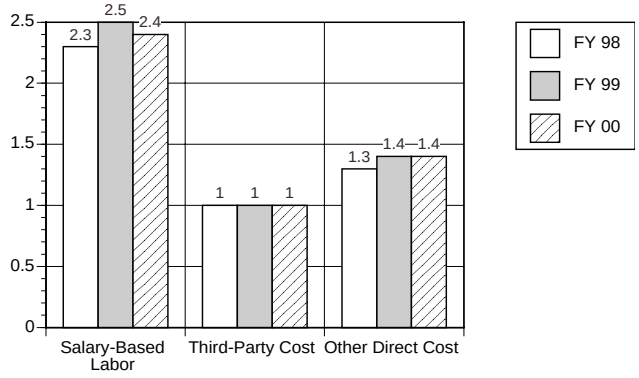
Energy Resources: Accomplishing NREL's mission requires strategically formulated partnerships with universities, industry, endusers, policymakers, and others. From its inception, NREL has actively sought these partnerships, and purposefully uses about half of its funding annually to involve these partners collaborative R&D; NREL also uses CRADAs, work-for-others agreements, and other formal and informal partnerships. These partnerships share technical knowledge developed at NREL with industry and endusers and infuse real-world experience into NREL's technology development efforts.

Category/Mission	*Partner*	*Description*
Energy Resources	Historically Black Colleges and Universities	Conduct solar radiation and photovoltaic research, and further science and engineering education; 8 universities
	Other Federal Agencies, DOE Field Offices	Provide centralized assistance for federal agencies to meet energy goals set for federal agencies (Federal Energy Management Program Network)
	Environmental Protection Agency	Collaborate on research involving sustainable design for laboratory buildings, climate change, climate stabilization, and renewable energy technologies
	NASA	Collaborate on research on photovoltaic space cells and solar radiation
	State Energy org'ns and officials	Provide training, technical assistance, and project development assistance to renewable energy and energy efficiency
	Electric Utilities	Collaborate on developing renewable electric technologies with focus on integration of distributed or intermittent systems, storage, systems engineering
	PV industry, Endusers, DOE Labs, Universities	Develop and accelerate adoption of photovoltaic technology through the National Center for Photovoltaics and four PV National Partnership Teams
	Wind industry, Endusers, Universities, DOE Labs	Develop and accelerate adoption of wind energy technology through the National Wind Technology Center
	Agribusiness and chemical industry	Develop biotechnology and other approaches to produce biofuels and chemicals from biomass; formalized agreements with 50-75 organizations
	Automotive Industry	Provide engineering and design models for hybrid vehicles; develop new catalytic converter
	Building industry, Endusers, DOE Labs	Develop and accelerate adoption of building energy technologies and whole building system design approproaches
	Foreign Governments, USAID, UN, World Bank	Collaborate on research and provide technical assistance on renewables to major international organizations and 20-25 specific countries
	Former Soviet Union countries and DOE Labs	Engage scientists and engineers from former weapons institutes into energy and other commercial, non-weapons related research projects
Science & Technology	Universities, DOE Laboratories, Int'l Labs	Collaborate on basic research related to renewable energy technologies through subcontracts and informal collaborations
National Security	Bettis Atomic Power Lab (DOE/DP)	Develop thermophotovoltaic energy sources for specialty power needs

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Princeton Plasma Physics Laboratory

Laboratory Information

Location: Princeton, New Jersey
Number of Full-Time Equivalent Employees: 523
Scientific and Technical Degrees: 239
Contractor: Princeton University
Accountable Program Office: Science
Field Office: Chicago Operations Office
Web Site: http://www.pppl.gov

Funding Sources

Science: $65.7 million
Nuclear Energy:
Energy Efficiency and Renewable Energy:
Environmental Management: $2.8 million
National Security and Nonproliferation:
Fossil Energy:
Other DOE:
Non-DOE: $2.0 million

Total Funding: $70.5 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

The Princeton Plasma Physics Laboratory is a collaborative national center for plasma and fusion science, whose mission is to develop the scientific understanding and the key innovations which will lead to an attractive new fusion energy source. The Laboratory has a leading collaborative role, nationally and internationally, in developing the theoretical, experimental, and technological innovations needed to make fusion practical and affordable. The laboratory utilizes strengths in theory, diagnostics, and advanced concepts in interactions with major efforts worldwide. In 1999, the Princeton Plasma Physics Laboratory commissioned the National Spherical Torus Experiment, to study new confinement configurations. Operated by Princeton University since its inception in 1951, it is the only single-program Laboratory funded by the Department for the development of fusion energy, and for research and development in the underlying discipline of plasma science.

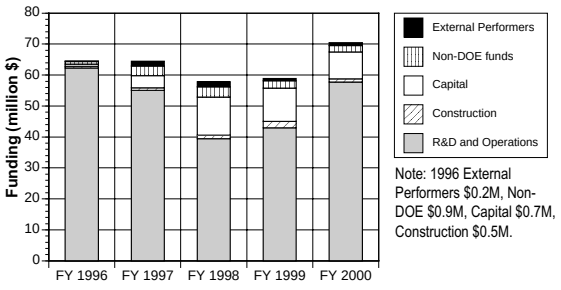
Distinctive Competencies and Major Facilities

The Laboratory has a highly skilled work force and unique capabilities for the experimental, theoretical, and computational study of plasma science, and particularly for the study of the physics of high-temperature fusion plasmas. It is a leader in the integrated design, fabrication, and operation of experimental facilities for fusion research and for basic and applied plasma research. Specific expertise includes: plasma diagnostics and instrumentation for the experimental analysis of the confinement and stability of high-temperature fusion plasmas, analytic plasma theory, advanced computational simulation of complex plasma systems, and design and construction of experimental plasma confinement and heating systems for fusion and basic plasma research.

The National Spherical Torus Experiment (NSTX) began operation in 1999 at the Laboratory. Constructed as a collaborative undertaking with Oak Ridge National Laboratory, the University of Washington, and Columbia University, is operated as a national user facility, currently involving researchers from 14 U.S. institutions. The Spherical Torus is an innovative fusion plasma confinement system, with the proven capability to confine stably plasmas at high beta (ratio of plasma pressure to magnetic field pressure). Research on NSTX will considerably broaden the scientific scope of high temperature plasma physics, and success in NSTX will open a new path to fusion power with much reduced development costs, and with an attractive power plant implementation.Other experiments at the Laboratory, on a more modest scale than NSTX, also investigate innovative approaches to fusion energy, and advance both plasma science and the applications of plasma science and associated technologies to national technological needs. Examples include experimental study of magnetic reconnection, the process responsible for dramatic Coronal Mass Ejections from the solar atmosphere, and research and development on plasma thrusters for satellite positioning, and on plasma display screens.

The Laboratory site comprises 72 acres, with large shielded experimental halls and associated office and manufacturing facilities.The site is well supplied with electrical power, and has extensive power conditioning hardware, including large motor-generators, rectifier arrays, capacitor banks, and switching equipment for the support of experimental operations. **The Tokamak Fusion Test Reactor (TFTR)**, located at the Laboratory, was the U.S. flagship fusion research device from 1982 to its shutdown in 1997. Many key scientific discoveries were made with this device, and world records were set in plasma temperature and fusion power production. Decontamination and decommissioning of the TFTR device began in FY00, in order to make room for future experiments in the large TFTR Test Cell.

Funding by Activity

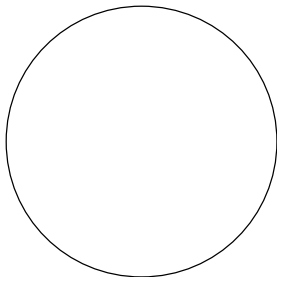


Note: 1996 External Performers $0.2M, Non-DOE $0.9M, Capital $0.7M, Construction $0.5M.

Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

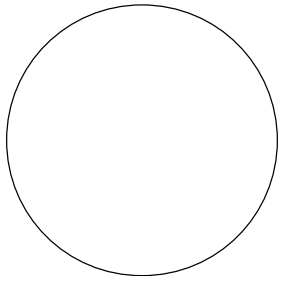
Funding by Mission Area

R&D Funding by Mission Area Total: $70.5 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $70.5 million



Note: Mission Footprint excludes remediation funds.

Princeton Plasma Physics Laboratory

Key Research and Development Activities

Science and Technology Mission

The Laboratory's research and development activities are focused on advancing the knowledge base of plasma and fusion science and technology, leading to an attractive fusion energy source. The goals will be achieved through:

— *Operating the National Spherical Torus Experiment (NSTX) as a national facility to test the fundamental plasma confinement properties of the Spherical Torus concept.* NSTX is a key element of the restructured U.S. Fusion Energy Sciences program, which focuses domestic activities on the development of cost-effective innovative paths to an attractive fusion power source. As an alternative to the tokamak, but taking advantage of much of the plasma science developed with tokamaks, NSTX will contribute to the understanding of plasmas in a new regime with the promise of order-unity beta, near neoclassical ion heat flux, efficient non-inductive plasma startup and current sustainment, and highly dispersed heat flux at the point of plasma-material contact.

— *Advancing the computational simulation of complex plasma systems.* Because the underlying equations of plasma science are well known, and because scalable algorithms are already in place for implementing plasma simulations on parallel computer systems, plasma science and fusion energy science are extremely well positioned to take advantage of the next generation of massively parallel computer systems. The Laboratory is at the forefront of the effort to advance computational plasma science in this arena, in order to facilitate more rapid innovation in fusion plasma confinement systems.

— *Collaborating on major national and international experimental facilities by mounting the Laboratory's plasma diagnostics and heating systems, and by analyzing and interpreting data.* The Laboratory's researchers collaborate on experiments at General Atomics in San Diego, CA, at MIT in Cambridge, MA, and at multiple other universities in the U.S., as well as at major fusion research facilities in Japan, England, France, and Germany.

— *Advancing the development of other innovative concepts for fusion energy, such as the Compact Stellarator and the Field-Reversed Configuration.* The Laboratory is working with Oak Ridge National Laboratory and the University of Texas to develop a new class of plasma confinement configurations, called Compact Stellarators. These new stellarator designs should permit much higher power density and therefore ultimately much more cost-effective fusion systems than stellarator concepts being pursued in major experiments abroad. The Laboratory is also working with the University of Washington and with General Atomics to advance the theory of the Field Reversed Configuration, a more speculative fusion confinement concept, which could lead to a highly compact and efficient fusion power source. Experimental facilities for the study of both of these innovative plasma confinement concepts at the Laboratory are under design.

— *Developing a wide range of areas of plasma science and technology, in support of national Science and Technology goals.* There are multiple interactions of plasma science with, for example, space physics, astrophysics, and the physics of intense ion beams. The Laboratory's researchers participate in each of these areas of plasma science. Areas of plasma technology research and development under study at the Laboratory include, inter alia, understanding and optimization of plasma thrusters, plasma displays, and methods of pasteurization and sterilization.

Significant Accomplishments

— High Current Spherical Torus Operation: 1999 - the highest plasma current of over 1MA achieved in a spherical torus plasma.

— Central Plasma Pressure: 1996 - the highest central plasma pressure in a deuterium/tritium plasma of 7.2 atmospheres was achieved.

— Enhanced Reverse Shear: 1995 - discovered the enhanced reversed shear confinement technique, which has the potential to lead to more compact, economical fusion power plants.

— World Record Fusion Power: 1994 - world record 10.7 MW of controlled fusion power produced by TFTR in the world's first experiments using a 50/50 mix of deuterium and tritium. Deuterium-tritium confinement is found to be 25% better than it is with deuterium alone. (This record was surpassed by the Joint European Torus in 1997.)

— Alpha Particle Measurements: 1994 - first measurements of alpha particles from fusion reactions.

— Neutral Beam Power: 1994 - record 40 MW of neutral beam injection into fusion plasma; achieved ion temperatures in excess of fusion reactor requirements.

— Differential Atmospheric Tritium Sampling System: 1990 - developed means to sample stack gases and differentiate between elemental tritium and tritium oxide.

— Bootstrap Current: 1986 - produced the first demonstration of tokamak bootstrap (thermo-electric) current driven by pressure gradients within the plasma itself, rather than by external means.

— Motional Stark Effect: 1984 – first measurement of internal magnetic fields in a fusion plasma using motional Stark effect on energetic hydrogen atoms.

— Fishbone Instability: 1982 - discovered first beam-plasma instability in a toroidal plasma.

— Current Driven Plasma: 1981 - produced the first tokamak discharge in which plasma current is driven entirely by lower hybrid radio frequency waves.

— Fusion Relevant Temperatures: 1978 - achieved fusion relevant plasma temperatures with neutral beam heating.

— High Resolution X-ray Spectroscopy: 1978 – first demonstration of high resolution, curved Bragg crystal X-ray spectroscopy for plasma ion temperature diagnosis, subsequently used in satellite observations of solar corona.

— TV Thomson Scattering: 1976 – first multi-point Thomson scattering measurement of electron temperature, using 2-D image-intensification techniques.

— Tokamak Heating: 1972 - demonstrated strong plasma heating with neutral beams and ion cyclotron waves.

— Tokamak Confinement: 1970 - demonstrated good plasma confinement in a tokamak experiment.

— Magnetic Divertor: 1965 - demonstrated operation of a magnetic plasma divertor.

— Developed Stellarator Concept: 1958 - developed stellarator concept of plasma confinement.

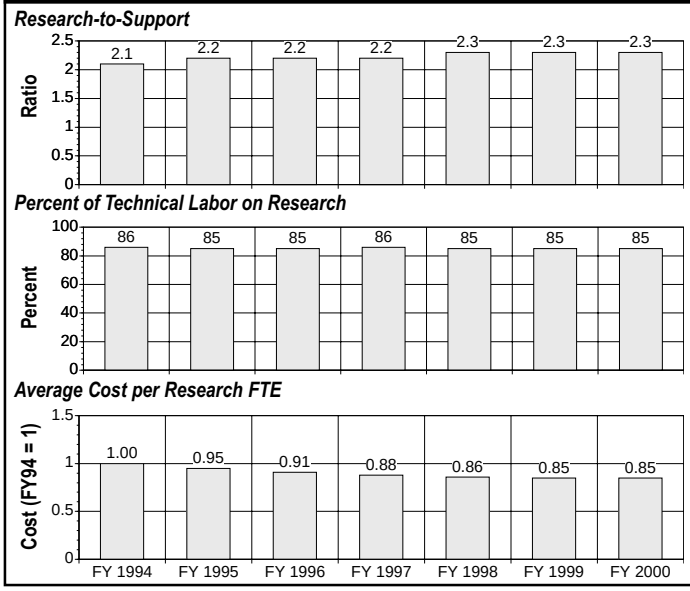
— MHD Theory: 1955 - used magnetohydrodynamic theory to formulate a variational energy principle.

Princeton Plasma Physics Laboratory

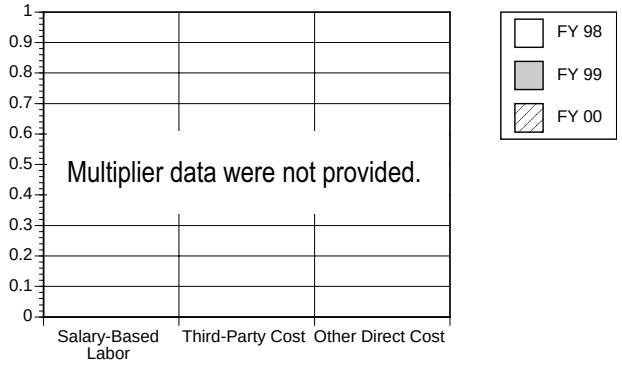
Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

Category/Mission	*Partner*	*Description*
Science and Technology	Princeton University	Collaborator w/PPPL for computational initiatives and societal initiatives as they relate to fusion research.
	General Atomics	Collaborating on plasma science and fusion research
	Massachusetts Institute of Technology	Collaborating on plasma science and fusion research
	Oak Ridge National Laboratory	Collaborating on plasma science and fusion research
	Columbia University	Collaborating on plasma science and fusion research
	New York University	Collaborating on plasma science and fusion research
	University of California	Collaborating on plasma science and fusion research and the conceptual study of innovative fusion power systems (ARIES Project)
	University of Washington	Collaborating on plasma science and fusion research
	University of Wisconsin	Collaborating on plasma science and fusion research
	University of Texas at Austin	Collaborating on plasma science and fusion research
	Los Alamos National Laboratory	Collaborating on plasma science and fusion research (APT)
	Lawrence Livermore National Laboratory	Collaborating on plasma science and fusion research (National Ignition Facility)
	Sandia National Laboratory	Collaborating on plasma science and fusion research
	US Department of Agriculture	Collaborating on the pasteurization of milk utilizing radio frequency heating sources used in fusion research
	NASA	Collaborating on magnetic reconnection
	Office of Naval Research	Collaborating on plasma science and magnetic reconnection
	US Air Force	Collaborating on plasma science and plasma thrusters
	International Partners (Europe, Asia)	Collaborating on JET, JT60U, LHD, KSTAR, MAST and Textor projects
	Johns Hopkins University	Collaborating on plasma science and fusion research

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Savannah River Technology Center

Laboratory Information

Location: Aiken, South Carolina
Number of Full-Time Equivalent Employees: 745
Scientific and Technical Degrees: 179 Ph.D's; 112 Master's; 186 Bachelor's
Contractor: Westinghouse Savannah River Co.
Accountable Program Office: Environmental Management
Field Office: Savannah River Operations Office
Web Site: http://www.srs.gov/general/sci-tech/srtc-home-map.shtml

Funding Sources

Science:
Nuclear Energy:
Energy Efficiency and Renewable Energy: $0.2 million
Environmental Management: $63.1 million
National Security and Nonproliferation: $29.3 million
Fossil Energy:
Other DOE:
Non-DOE: $21.2 million

Total Funding: $113.8 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds of $6.8 million.

Description

Savannah River Technology Center (SRTC), formerly known as the Savannah River Laboratory, was established in 1951 to support the production of nuclear materials for national defense at the Savannah River Site. SRTC is an applied research and development laboratory which supports national defense through its technologies and capabilities in non-proliferation and Tritium processing, environmental management through deployment of new technologies to stabilize and dispose of nuclear materials such as high level waste and low level waste, and clean up of groundwater and soils. Because of its applied nature, the Center supports the Savannah River Site, major Departmental programs at national laboratories, and to a lesser extent other Federal agencies such as Defense, Transportation, Justice, the Nuclear Regulatory Commission, and commercial entities. Savannah River Technology Center engages in a wide range of partnerships with industry, academia, national laboratories, and government agencies to ensure program success and increase U. S. industrial competitiveness. In 1995, the landlord for the laboratory transferred from Defense Programs to the Office of Environmental Restoration and Waste Management.

Distinctive Competencies and Major Facilities

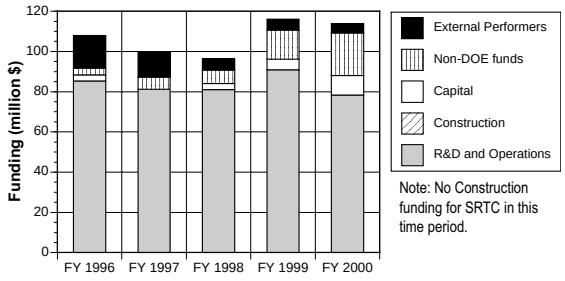
Distinctive Competencies and Major Facilities

The Savannah River Technology Center is distinguished by its ability to solve complex problems requiring the integration of technical disciplines, specialized facilities, and highly unique operations expertise. SRTC defines its nine core competencies as follows:

— **Waste Processing**: Liquid effluent and process treatment for high level radioactive waste; solid waste processing including decontainerization, containment, and encapsulation; waste packaging design and certification; radioactive material storage technology.
— **Vitrification**: Custom glass formulation; off-gas system design; integrated vitrification systems for high-level radioactive waste streams.
— **Environmental Remediation**: Environmental biotechnology; groundwater remediation systems; treatment and stabilization of secondary wastes; risk-based ecological remediation; field screening and technology demonstrations.
— **Actinide Processing**: Plutonium (and other actinide) handling, separation, shipping, storage and immobilization capability.
— **Tritium/Hydrogen**: Hydride storage systems; tritium/hydrogen processing; molecular and process modeling; tritium effects on materials; packaging and transport technology.
— **Nonproliferation Technology and National Security**: Ultra-low level radiation detection and radionuclide analysis; classified programs; environmental monitoring; atmospheric modeling.
— **Instruments and Sensors**: Fiber optic spectroscopy; high sensitivity analytical instruments and sensors; high-resolution non-destructive imaging using ultrasonic and digital radiography (NDE); coulometry/calorimetry/density (NDA); advanced instrument system integration and packaging.
— **Remote Systems**: Mobile remote surveillance & handling systems; vision systems; pipe/wall crawlers; special engineered equipment systems.
— **Aluminum reactor fuel**: Treatment and disposition technologies for aluminum research reactor spent fuel.
— **Enabling Technologies**: analytical chemistry; computational science and advanced computing, modeling, and statistics; materials technologies.

The Center's major facilities include: Chemistry and Analytical Laboratories, Intermediate and Shielded Cells, a tritium Material Test Facility, Plutonium immobilization melters, Environmental and Biotechnology Laboratories, an Integrated Environmental Remediation Site, Ultra-Low Level Counting Facilities, a Remote Systems Laboratory, a Thermal Fluids Laboratory, a Scientific Computing Resource Center and a TRAC (Tracking Radioactive Atmospheric Contamination) vehicle.

Funding by Activity

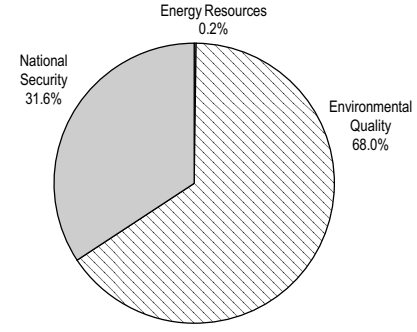


Note: No Construction funding for SRTC in this time period.

Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

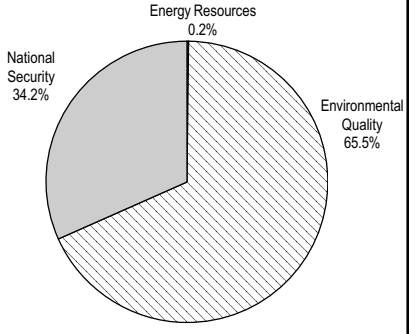
Funding by Mission Area

R&D Funding by Mission Area Total: $92.6 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $113.8 million



Note: Mission Footprint excludes remediation funds.

Savannah River Technology Center

Key Research and Development Activities

Environmental Quality Mission: Principal focus areas include characterization, assessment, and remediation of legacy nuclear material and chemical wastes and contaminated sites. Approximately 100 technology deployments have been achieved on and off the site. These remediation technologies have also been successfully transferred to other Department of Energy sites, federal agencies, and private industry. Activities include:

- Providing process and equipment improvements to the Defense Waste Processing Facility which have extended the service of the melter by 200% and allowed an increase pour rate of canisters.
- Development of alternative salt pre-treatment technologies and processes.
- Characterization of waste in high-level waste tanks and recommendations for disposal of subject waste at the Savannah River Site and other Department sites.
- Developing grout formulations for closure of High Level Waste tanks.
- Development of a process to provide a long term storage form for americium and Curium.
- Optimization, development and/or deployment of groundwater and soils clean-up, subsurface barrier/stabilization and biomediation systems.
- Application of risk-based analyses for selection, design and deployment of ecological technologies.
- Development of alternative protocols to meet environmental compliance requirements.

National Security Mission: The Technology center supports the U.S. objectives of non-proliferation of special nuclear material and the maintenance of the country's nuclear stockpile including the support of new mission development for Savannah River Site Canyon activities. Activities include:

- Development and application of unique processes for the storage, separation, and purification of tritium for the Department's weapons programs.
- Development of inspection, loading, and testing technology for gas transfer systems.
- Sharing of technical expertise for the Tritium Extraction Facility, the Commercial Light Water Reactor Tritium Production Program, and the Accelerator for the production of Tritium program.
- Providing of technical expertise/experience and measuring devices (e.g., coulometers) for National and International Safeguards Programs (e.g., treaty verifications, forensics, export control, etc.).
- Supporting the Federal Bureau of Investigation in nuclear forensics activities.
- Development of processes for Plutonium immobilization such as the can-in-canister disposal method.

Science and Technology Mission: SRTC conducts activities in actinide chemistry, vitrification, materials sciences, remote systems, and modeling to support Department new missions. Activities include:

- Development of materials specification and selection, materials testing and analysis, and environmental degradation evaluations for all site operations (e.g., the APT, tritium, SNF, TRU Waste, HLW Chemical Processes, and DWPF) and offsite customers consistent with Departmental guidance.
- Development of flowsheets for chemical processes to stabilize nuclear materials. Development of alternate technology to reprocessing for the stabilization of SNF.
- Application of modeling techniques to more cost effectively optimize new technology developments.
- Promotion of remote equipment and systems to support safety, security surveillance, reduced radiation exposure, and improved the quality of processes.
- Development of measurement and collection techniques for high-sensitivity environmental detection programs in support of international non-proliferation.
- Development of remote fiber optic based sensors in support of specialized measurement needs within the Department.

Energy Resources Mission: Apply knowledge of tritium handling and storage to promote hydrogen as a viable energy source. Major activities include:

- Development of a new metal hydride based hydrogen storage system for the Industrial Fuel Cell Vehicle Program.
- Development of a new hydrogen filter for hydrogen energy applications.

Significant Accomplishments

Stockpile Stewardship (1989 to present): SRTC provided significant support to the tritium weapons design authority including reclaiming reservoirs in support of valve testing activities, using the SRTC developed Dimensional Inspection and Imaging Measurement System for production inspection of unconfined pinchwelds on reservoirs, and the development of an ultrasonic testing technique for the inspection of 1K reservoirs. SRTC continued to lead the Tritium Reservoir Surveillance and Life Storage Programs in support of the U.S. nuclear stockpile maintenance. SRTC also made significant contributions to the Tritium Extraction Facility program though its certification of the Tritium Extraction System computer model and the successful completion of factory acceptance testing at a furnace vendor shop. SRTC enabled the successful transfer of the Lead Test Assemblies from Watts Bar Nuclear Plant to Argonne National Laboratory-West in support of the Commercial Light Water Reactor Tritium Production Program. SRTC provided significant support to the lead laboratory in the Accelerator Production of Tritium program.

Waste Management and Stabilization Technologies (1980 to present): SRTC has been a leader in characterizing, assessing, and stabilizing legacy nuclear and chemical wastes. The Technology Center has played a major role in the U.S. high-level nuclear waste disposal program and in demonstrating the viability of a variety of waste forms and treatment options including vitrification technology. SRTC has developed innovative solutions to melter problems at the Defense Waste Processing Facility that have extended the service life of the melter by 200% and increased the pour rate of canisters. SRTC has also played a major role in the Hanford Waste Tank Remediation program by providing technical and analytical expertise to the prime contractor, British Nuclear Fuels Limited. SRTC also provided the technical expertise that allowed the first high-level waste tank in the DOE complex to be closed at the Savannah River Site. SRTC had back-to-back winners of the prestigious Seaborg Award for excellence in actinide chemistry.

Environmental Technologies (1995 to present): SRTC has been a leader in the characterization, assessment, and remediation of legacy nuclear and chemical waste contaminated sites. The Technology Center has developed, tested, demonstrated, and deployed new technologies to solve DOE and industrial environmental problems. Advanced characterization techniques, new separation agents for volume reduction, techniques for chemically or biologically modifying the contamination, and advanced delivery systems are among the accomplishments. Included in SRTC developed technologies are a system to passively induce contaminated groundwater flow through an in-situ permeable treatment media at an accelerated rate by using the natural hydraulic head difference between two points (GeoSiphon), a remediation technique that removes volatile contamination from soil in the vadose zone using a valve on the well head that allows soil gas to flow out while restricting air flow into the well (BaroBall), and a unique vapor phase system to deliver phosphorous feedstock to microbes used in remediation (PHOSter). SRTC was co-editor on the handbook Vadose Zone Science and Technology Solutions. SRTC has also provided key scientific support to the mercury Total Maximum Daily Load program. SRTC is also the lead laboratory for the Subsurface Contaminant Focus Area group within the DOE complex.

Nuclear Material Storage (1995 to present): SRTC has produced a low cost, high quality storage system for special nuclear material (SNM). The Bagless Transfer system developed at SRTC and installed in the FB-line at SRS has allowed the repackaging of SNM without the use of organic material. The success of this system has been transferred to another DOE site with an additional two sites interested in obtaining the system. SRTC also developed and demonstrated the concept of encapsulating excess weapons grade plutonium in high-level waste glass as part of the U.S. efforts in arms control and non-proliferation.

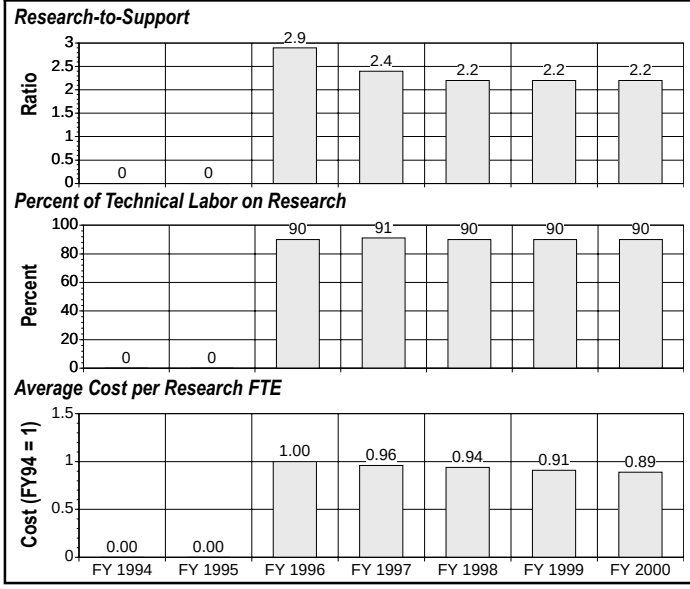
Nuclear Material Control and Accountability (1998 to present): SRTC has made significant contributions to the international community's ability to account for and control special nuclear material. SRTC has delivered high-precision coulometer systems for nuclear material security to the Mayak Production Facility in Ozersk, Russia, the International Atomic Energy Agency in Vienna, Austria, and the Power Reactor and Nuclear Fuel Development Corporation of Japan for their Tokai-mura reprocessing facility. SRTC is presently fabricating coulometers for Mitsubishi Heavy Industries for their Rokkasho reprocessing plant.

Savannah River Technology Center

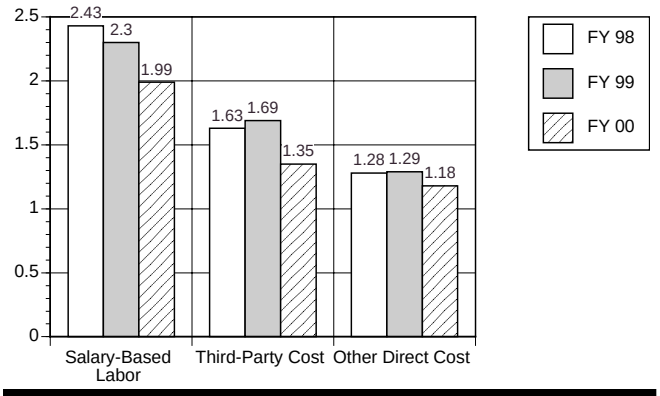
Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

Category/Mission	*Partner*	*Description*
Environmental Quality	University of Georgia, Clemson University	SR Ecology Lab provides environmental studies as related to Savannah River Site.
	Clemson University	Vitrification Center, consulting services on preparation and processing of samples for radiological analysis, design of wetland waste water treatment systems and soil vapor extracting.
	Pacific Northwest National Laboratory	Support Tank Focus Area Technical Team
	Lockheed Martin Energy Research	Develop, design, fabricate, and deploy an inspection device to inspect U-233 canisters. Assess inspection device utilizing radiographic imaging techniques.
	Idaho Operations Office	Participate in release testing activities for fissile material and fission products.
	Oak Ridge Operation Office	Technical support for the Transportable Vitrification System (TVS), alternate salt disposition, and geosiphon deployment.
	INEEL	Memorandum of Mutual Intent.
	Argonne National Laboratory	Development of EMSP-96.
	Rocky Flats Field Office	Procure and certify 9975 shipping containers. Provide metallography and digital radiography tests on plutonium SPS containers.
	CH2M Hill Hanford	Waste processing testing and demonstrations for Hanford Waste Tank Remediation System.
	Lawrence Livermore National Laboratory	Plutonium immobilization, Enhanced Surveillance Program (DP), and environmental technology deployments (geosiphon, purge water management system).
National Security	Los Alamos National Laboratory	Provide technical support to LANL on 94-1 research & development tasks. Provide/upgrade pinch welder data acquisition system.
	Sandia National Laboratory	Support Defense Programs Analysis Group at SNL.
	U.S. Department of State	Coulometer development, fabrication,delivery, and training as part of the U.S.Dept.of State Program of Technical Assistance to IAEA Safeguards Program(POTAS).
	PowerReactor & Nuclear Fuel Dev.Corp of Japan	(PNC)Coulometer development, fabrication, delivery, and training for the Tokai-mura Nuclear Processing Plant.
Science & Technology	South Carolina Universities	SC Universities Research and Education Foundation (SCUREF), a consortium of 5 South Carolina Universities that provide cross cutting R&D support.
	Georgia Universities	Energy, Research and Development of Georgia Universities (ERDA), a consortium of 5 Georgia Universities that provide cross cutting R&D support.
	Nuclear Regulatory Commission	Develop a coatings failure model for Nuclear Power Plant containment protective coatings. Safety testing of sealed sources and devices.
	Enviromental Protection Agency	Develop mobile laboratory specifications.
	Federal Energy Technology Center	Support site characterization at Cape Canaveral Air Station.
	Allied Signal Aerospace	Deliver hydrogen sensos and provide pinch welding and finishing services on stems for Acorn Cutaway provided.
	CECOM/NVESD	U.S.Army Command &Electronics Commands Night Vision &Electronics SensorsDirectorate-Development of Microbial Mine Detection System (MMDS).
	Southeastern Technology Center	Development of a hydrogen storage system for Industrial Fuel Cell Vehicles (IFCV). Environmental sciences and restoration technical consulting services.

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Stanford Linear Accelerator Center

Laboratory Information

Location: Menlo Park, California
Number of Full-Time Equivalent Employees: 1,417
Scientific and Technical Degrees: 220 Ph.D's
Contractor: Stanford University
Accountable Program Office: Science
Field Office: Oakland Operations Office
Web Site: http://www.slac.stanford. edu

Funding Sources

Science: $184.8 million
Nuclear Energy:
Energy Efficiency and Renewable Energy:
Environmental Management:
National Security and Nonproliferation:
Fossil Energy:
Other DOE:
Non-DOE: $15.2 million

Total Funding: $200 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

Stanford Linear Accelerator Center was founded in 1962 as a national user facility for high-energy physics using electron beams in a two-mile linear accelerator. In the '70s the Center developed electron-positron colliding beam storage rings, which have been an important aspect of high energy physics ever since. The SPEAR storage ring has been used for synchrotron radiation research. In 1998, the Asymmetric B Factory was completed. The Center conducts experimental and theoretical research in elementary particle physics using electron beams and particle astrophysics, plus a broad program of research in atomic and solid state physics, chemistry, biology, environmental science, and medicine using synchrotron radiation. It develops accelerators, sources, instrumentation and detectors for high-energy physics research and synchrotron radiation research, including a very high energy linear collider and a coherent one-angstrom free electron laser. It is a major center of support for US research, and for training of the next generation of scientists. Approximately 2500 users participate in the high energy physics and synchrotron radiation research programs.

Distinctive Competencies and Major Facilities

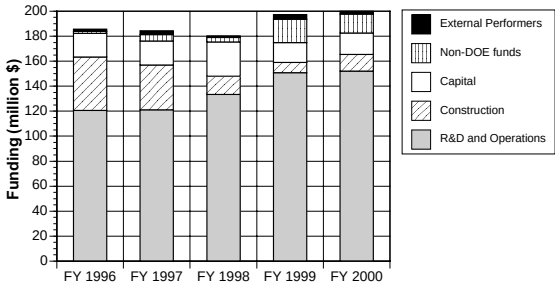
The Center is the leader in the design and construction of linear accelerators and storage rings that deliver intense, energetic and extremely bright beams of electrons and photons for use in particle physics, materials science, molecular biology, environmental science, medicine and other scientific research fields. Supporting these activities are distinctive core competencies in:

- high-power sources of microwave radiation to power these machines
- fabrication and support of large-scale experimental facilities and detectors for accelerator-based and satellite-based particle physics
- optical systems and detectors for x-ray beams and charged particles needed to exploit these facilities
- synchrotron radiation research capabilities in a wide variety of disciplines
- high-speed computers for accelerator and experimental control, analysis of enormous data sets, and global communications via the World Wide Web.

The Center's major facilities include:

- The world's largest linear accelerator, **Stanford Linear Accelerator Center** delivers 50 billion volt (50 GeV) electron (including polarized electron) and positron beams
- The **B Factory**, a state-of-the-art asymmetric electron-positron collider and associated particle detector for research on B mesons
- A 3 GeV electron storage ring, SPEAR, for production of ultraviolet and x-ray for use in synchrotron radiation research
- A large concrete-shielded building for experiments with stationary targets
- Two major accelerator physics R&D facilities to test subsystems and features of future accelerators

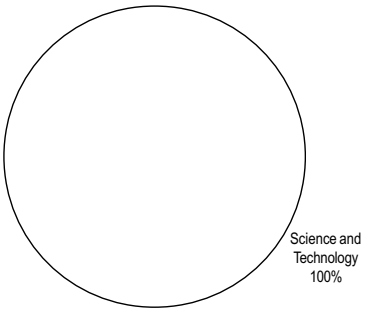
Funding by Activity



Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

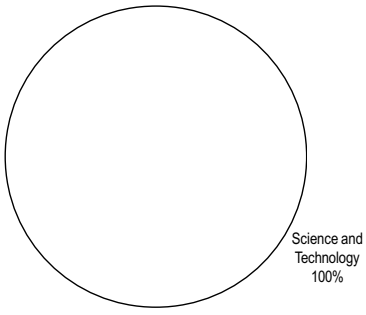
Funding by Mission Area

R&D Funding by Mission Area Total: $192.3 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $199.4 million



Note: Mission Footprint excludes remediation funds.

Stanford Linear Accelerator Center

Key Research and Development Activities

Science & Technology Mission

- Research at the B Factory on the production and decay of B mesons, aimed at better understanding the asymmetry between matter and antimatter—why there is such a great preponderance of matter in the Universe.
- Continuing studies at the linear collider on production and decay of the massive Z particle, testing the dominant Standard Model of particle physics.
- Major research and development projects required for conceptual design of a next-generation linear collider NLC (Next Linear Collider), intended to operate at energies around one trillion electron volts.
- Ongoing experiments using polarized electron beams on stationary targets to study the quark substructure of protons and neutrons and try to unravel the mystery about the origin of their spin quantum numbers.
- Research and development toward a space-based gamma-ray telescope to study phenomena orginating in regions of very high-field relativistic gravity.
- Research and development projects to evaluate advanced particle acceleration techniques that exceed the limits of current technologies.
- Research employing synchrotron radiation in the disciplines of condensed matter physics, chemistry, materials science, structural molecular biology, molecular environmental science, and medicine.
- Development of advanced devices for producing synchrotron radiation and of new instrumentation for use in scientific research.
- Development of a fourth-generation synchrotron light source based on the conversion of a portion of the linear accelerator into a free-electron laser.

Significant Accomplishments

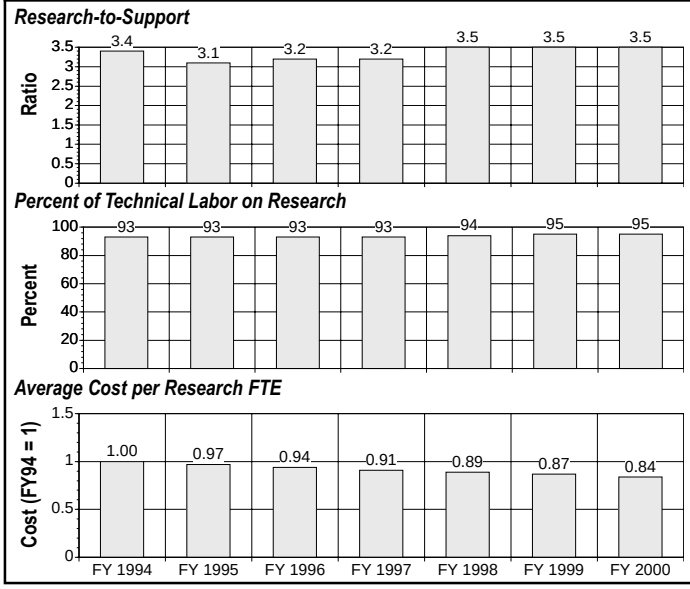
2000:	H. Kamerling Onnes Prize to Z. X. Shen for work on high temperature superconductors
2000:	SLD published the world's most precise determination of the weak mixing angle; a stringent constraint on the mass of the Higgs boson
1999:	Completed B Factory/Detector, the world's first asymmetric energy electron-positron collider, on budget and on schedule.
1998:	Stanford Linear Collider attained record collision rate.
1996:	Final Focus Test Beam achieved world's narrowest electron beam, with a thickness of only 70 nanometers.
1995:	Nobel prize awarded Martin Perl for his 1976 discovery of the tau lepton, a heavy cousin of the electron, at the SPEAR storage ring.
1990:	Nobel prize awarded to Richard Taylor jointly with two others from MIT for discovery of experimental evidence for quarks
1989:	Discovery of evidence that there are only three fundamental families of quarks and leptons in Nature, limiting its complexity.
1989-1998:	Operation of the world's first (and so far only) linear collider, the Stanford Linear Collider (SLC).
1987-today:	Developed EGS software now used hospitals around the world for research and clinical planning of radiation therapy
1981:	Development of near edge x-ray absorption fine structure (NEXAFS) technique
1980:	First operation of the PEP electron-positron collider.
1980:	Development of multiwavelength (now usually called MAD) phasing technique for x-ray crystallography
1980:	Operation of first permanent magnet undulator in SPEAR and use for x-ray science
1980:	Oliver E. Buckley Prize to William Spicer for pioneering development of Photo emission Spectroscopy.
1978:	Development of surface extended x-ray absorption fine structure (SEXAFS) technique
1978:	Operation of first wiggler insertion device (electromagnet) in SPEAR and use for x-ray science
1976:	First use of synchrotron radiation for x-ray diffraction study of protein crystals
1976:	Nobel prize awarded Burton Richter for pioneering electron-positron colliders and discovery of the psi particles at SPEAR.
1974-80:	Development of extended x-ray absorption fine structure (EXAFS) technique into a reliable structural tool
1974-today:	Developed the world's first high-intensity synchrotron-based source of x-rays and pioneered its use in many research fields.
1971-72:	Built and operated the world's first high-intensity electron-positron storage ring (SPEAR).
1961-66:	Built and operated the world's longest and highest-energy linear accelerator.

Stanford Linear Accelerator Center

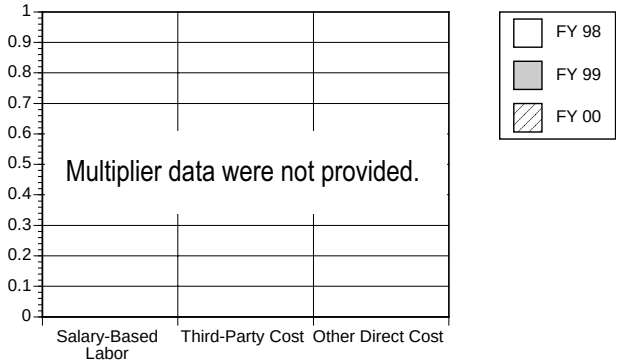
Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

Category/Mission	*Partner*	*Description*
Science and Technology		SLAC's collaborations primarily support the scientific research mission of the Department of Energy in the areas of accelerator technology, high energy physics and synchrotron radiation physics. Most recently the efforts of SLAC, LBNL and LLNL worked as a system to create the B Factory at PEP II. The NLC collaboration will likely lead to an international system of laboratories to build and operate that facility. By participating in CRADAs and other programs SLAC's unique facilities and expertise in accelerator technology, experimental techniques and synchrotron radiation are frequently used to provide a means of technology transfer to the private sector.
	LBNL, LLNL, China, Russia	Design and construction of PEP-II asymmetric B Factory at SLAC by an internationa led by the three DOE national laboratories.
	Universities, FNAL, LBNL, LLNL, Other nations	Design and construction of BaBar, a sophisticated particle detector at the B Factory, by an international collaboration of 600 physicists from 80 institutions in 10 countries.
	Universities, Other Federal Labs, Other nations	International collaboration of DOE Labs and the Japanese national laboratory KEK in an R&D program for the next-generation linear electron-positron collider, to operate at energies around 1 TeV.
	Universities, Other DOE Labs, Other nations	Synchrotron Radiation User Partnerships, involving 1600 scientists from 83 universities, 19 federal laboratories, and 17 foreign countries, to do research in materials science, molecular biology, environmental science, chemistry, medicine.
	Universities, Other U.S. Labs, Other Nations, Industry	International collaboration of over 100 scientists from 28 institutions, working with NASA scientists to design the GLAST Detector for detection of high-energy gamma rays by a satellite in Earth orbit.
	Industrial firms	Industrial partnerships on high-power radio frequency tubes, micro contamination analysis, semiconductor process development, catolysis, detector development, and development of new drugs.
	Stanford University	Many of the scientific leaders at SLAC are also members of the University faculty.
	IBM	Team agreement on the synchrotron radiation beam line experimental station.
	Stanford University and Scripps Research Inst.	Participating Research Team agreement on the synchrotron radiation beam line experimental station.
	IHEP, China	Memorandum of Understanding for cooperative research with the Institute of High Energy Physics, Beijing, Peoples Republic of China.
	KEK, Japan	Memorandum of Understanding for cooperative research with the National Laboratory for Accelerator Research (KEK), Tsukuba, Japan.
	BINP, Russia	Memorandum of Understanding for cooperative research with the Budker Institute of Nuclear Physics, Protvino and Novosibirsk, Russia.

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

Thomas Jefferson National Accelerator Facility

Laboratory Information

Location: Newport News, Virginia
Number of Full-Time Equivalent Employees: 529
Scientific and Technical Degrees: 106 Ph.D's; 162 Bachelor's/Master's
Contractor: Southeastern Universities Research Association
Accountable Program Office: Science
Field Office: Oak Ridge Operations Office
Web Site: http://www.jlab.gov

Funding Sources

Science: $85.3 million
Nuclear Energy:
Energy Efficiency and Renewable Energy:
Environmental Management:
National Security and Nonproliferation: $0.4 million
Fossil Energy:
Other DOE:
Non-DOE: $9.5 million

Total Funding: $95.2 million

Note: Budget data shown are for FY00 and exclude remediation (cleanup) funds.

Description

Thomas Jefferson National Accelerator Facility, formerly known as the Continuous Electron Beam Accelerator Facility, is a national user facility for scientific research using continuous beams of high-energy (0.5-6.0 GeV) electrons to elucidate the underlying quark and gluon structure of nucleons and nuclei. The facility was constructed between 1987 and 1995 on a green site for $600 million. Complemented by the planned research at the Relativistic Heavy Ion Collider recently completed at Brookhaven National Laboratory, the Facility offers users unique capabilities for experiments studying atomic nuclei using electrons, our best understood probe particle. Machine capabilities include energies in the multi-GeV range—providing spatial resolutions ranging from the size of a large nucleus down to about one-tenth the size of a proton; high currents—permitting the study of reactions with very small cross-sections; highly polarized beams, permitting investigation of the spin and weak neutral current structure of nucleons and nuclei; and continuous beam operation—supporting precision coincidence experiments. The user community includes about 1600 members, with 869 actively engaged in experiments. The innovative design and technology of the accelerator allows a cost-effective upgrade to 12 GeV as driven by the user community and the science potential. The accelerator has the potential to go to 24 GeV. A spin-off of the Laboratory's accelerator technology is the 1-kW Infrared Free Electron Laser developed in collaboration with industrial, Navy, and university partners for industrial, defense, and research applications.

Distinctive Competencies and Major Facilities

Distinctive Competencies:

– Design, execution, and analysis of precision experiments involving studies of nucleons and nuclei by both electron scattering and photon-induced reactions, and involving: state of the art simulations; the design, construction, and operation of super-conducting spectrometers, advanced detectors, and polarized and cryogenic targets; and the use of very high-rate data acquisition and analysis systems.

– Theoretical calculations in both the quantum chromodynamics and conventional nuclear physics frameworks to interpret, analyze, and plan experiments, and to identify future research directions.

– Accelerator technology and accelerator physics expertise necessary to produce high brightness and highly-polarized continuous wave electron beams, including: superconducting radiofrequency technology; very large scale 2 K (superfluid) He cryogenics; large real-time control systems (>100,000 control points); and photocathode electron sources and advanced laser systems.

Major Facilities:

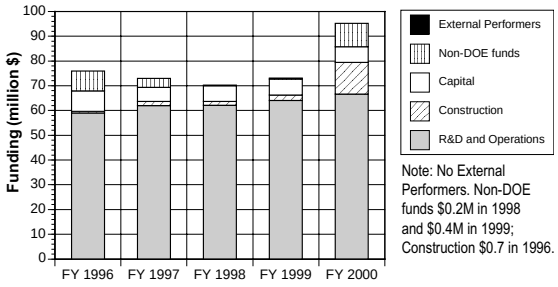
– **The Continuous Electron Beam Accelerator Facility (CEBAF)** provides continuous wave electron beams with energies from 0.5 to 5.7 GeV (6 GeV capability demonstrated), with currents from 100 pA to 200 μA and with polarization approaching 80% to three end stations simultaneously.

– Three end stations, each with a set of complementary experimental equipment. **Hall A** has a pair of superconducting, high-resolution magnetic spectrometers optimized for precision electron scattering coincidence experiments. **Hall B** houses **the CEBAF Large Acceptance Spectrometer (CLAS)**, a nearly 4pi detector and ancillary equipment that supports studies of both electron and monochromatic photon-induced reactions with loosely-correlated particles in the final state. **Hall C** contains a pair of moderate resolution spectrometers (one capable of high momentum particle detection and the second optimized for the detection of short-lived reaction products) and provides additional space and infrastructure for supporting major experiment setups optimized for specific measurements that cannot be carried out using available instruments.

– **The Testlab and Applied Research Center (ARC)**, providing state of the art surface science and supeconducting radiofrequency research and development and production capability.

– **The Infrared Free Electron Laser (IFEL)**, designed to provide 1 kW of infrared light with picosecond pulse length, transform limited bandwidth, and diffraction limited emittance.

Funding by Activity

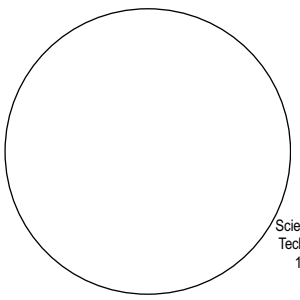


Note: No External Performers. Non-DOE funds $0.2M in 1998 and $0.4M in 1999; Construction $0.7 in 1996.

Note: Budget year data for FY 1996 to FY 00. Excludes site remediation.

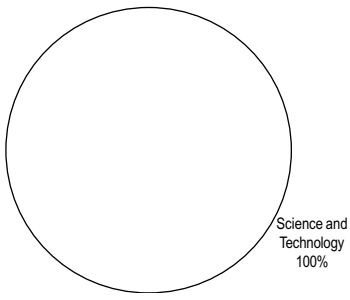
Funding by Mission Area

R&D Funding by Mission Area Total: $95.2 million



Note: R&D Footprint includes line item equipment; excludes remediation, other construction, general purpose equipment.

Total Funding by Mission Area: $95.2 million



Note: Mission Footprint excludes remediation funds.

Thomas Jefferson National Accelerator Facility

Key Research and Development Activities

Science and Technology Mission

— Nuclear Physics: The Continuous Beam Accelerator Facility and associated experimental equipment are addressing major open questions in nuclear physics: how the nucleons and mesons are constructed from the quarks and gluons of quantum chromodynamics; understanding the quantum chromodynamic origins of the strong interaction between the nucleons; and investigating the structure of atomic nuclei with an emphasis on identifying the transition between the standard neutron plus proton picture to the underlying quark structure.

— Accelerator Physics and Technology: Develop and refine processing and assembly techniques for superconducting cavities; refine cavity, coupler, and cryostat designs; integrate these results into upgraded cryomodules operating at > 15 MV/m cw with high Q values for applications in an upgrade of CEBAF to 12 GeV and high power free electron lasers; refine photocathode technology, using radiofrequency modulated lasers to produce intense (200μA) beams of highly (80%) polarized electrons for nuclear physics research.

— Free Electron Laser Development: Increase energy to extend wave length range: 1 kW in the deep ultraviolet (190 nm) for scientific and industrial applications; increase source capabilities to reach 10 kW in the infrared for defense-related research and industrial applications.

— Information Technology: Provide petabyte scale data acquisition and analysis systems with associated high-end simulation systems; develop and deploy 100,000 element scale real-time control systems.

— Detectors: Provide state-of-the-art particle detector systems.

— SNS: Design, fabricate, install and commission at ORNL a cryogenic linac system from 185 MeV to 1.0 Gev, including refrigerator, transfer lines, 26 cryomodules and a small SRF facility.

Significant Accomplishments

— Jefferson Lab is now routinely operating all three experimental areas (Halls A, B, and C), often sending polarized electron beams simultaneously to more than one area. Highlights of the physics program in Hall A include a first measurement of the strange form factor of the proton via parity violating electron scattering (demonstrating that the strange form factor of the proton is small) and a measurement of the ratio of the electric to magnetic form factor of the proton (demonstrating that the distribution of charge inside the proton differs from the distribution of magnetization). Highlights in Hall C include a separation of all three elastic form factors of the deuteron up to high momentum transfer via a measurement of the tensor polarization of the recoiling deuteron (demonstrating that classical nuclear physics with appropriate corrections describes the deuteron down to very small distance scales). In Hall B, the large acceptance detector CLAS has reached its design goals; first physics results include a measurement of the photoproduction of Phi-mesons up to large momentum transfer (demonstrating that the internal structure of the exchanged Pomeron needs to be taken into account).

— Polarized Source: 1999/2000—Jefferson Lab's polarized electron beam is delighting researchers with high levels of polarization and current, and with exceptionally high polarized source operational “up” time. Polarization refers to the state of electrons in the beam-getting millions of electrons rotating the same way as they move through the accelerator to the target material. Polarized beam allows physicists to add another parameter during an experiment - providing more control or more defined data. Delivered 75% polarization at 40mA during 1999. Achieved 430mA in test stand, operational in August 2000. On track to achieve 200mA at P=80%. Jefferson Lab has delivered more polarized electrons than all accelerators worldwide to date.

— Infrared Free Electron Laser Delivers Record-breaking Performance: 1998/1999—An infrared Free Electron laser based on the superconducting radiofrequency technology used in Jefferson Laboratory’s Nuclear Physics accelerator, delivered first light in June 1998 at 15 times the previous world’s record for a laser of this type. The FEL exceeded its design goal of 1,000 watts (a million times more powerful than the laser in a supermarket scanner) by producing 1,720 watts of infrared light in July 1999. In September 1999, the FEL also produced high brightness, short pulse x-rays by compton scattering. At kilowatt levels, the Jefferson Lab FEL offers researchers a unique tool for science and industrial processing with light. The FEL may have a wide range of applications in manufacturing, including processing of plastics, more durable synthetic fibers, corrosion resistant metals and advanced materials and components for electronics and microtechnologies. Initial industrial experiments are investigating roughening plastics, creating hardened and corrosion-resistant metal surfaces, and machining miniature structures in ceramics.

— Medical imaging clinical tests: 1998/1999— A new diagnostic tool has been developed by a spin-off company that helps detect breast cancer using licensed technology developed at DOE’s Jefferson Lab for its nuclear physics mission. This tool, approved by the FDA in March 1999, will use nuclear medical imaging known as scintimammography to pinpoint cancerous breast tissue. This technology can detect tumors that are five times smaller in volume than tumors detectable with standard mammography x-rays. This technology will be used when x-rays mammograms show an abnormality and will prevent some breast biopsies. Clinical trials were conducted at the University of Virginia and John Hopkins University. The device is currently being marketed by Dilon Technologies.

— Jefferson Lab began three hall operation for physics research: 1998—Jefferson Laboratory began three-hall operation of its three complementary experimental halls to explore the origins of quark confinement and structure of atomic nuclei. The Laboratory has already produced results in several world-class experiments including T20 (structure of the deuteron) and HAPPEX (a parity violation experiment on the strangeness structure of the nucleon)

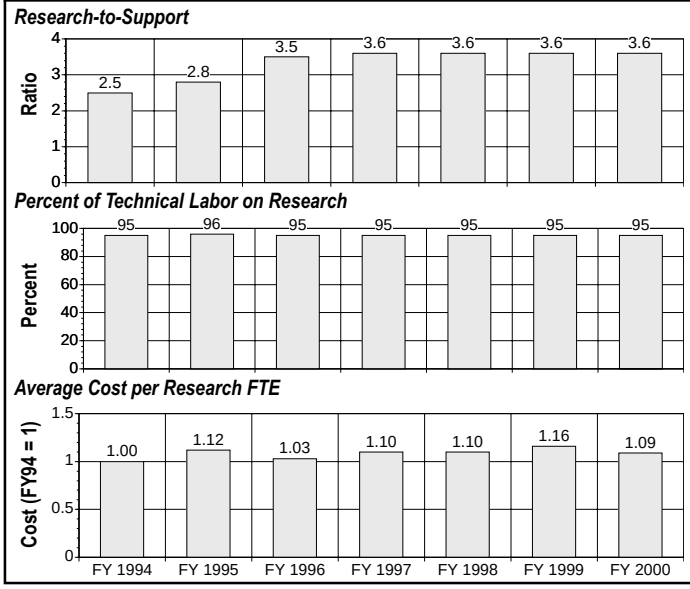
— On cost, on schedule delivery of largest-scale application of SRF technology: 1995—The Continuous Electron Beam Accelerator Facility (CEBAF, later dedicated Thomas Jefferson National Accelerator Facility) was completed on cost and on schedule, and delivered 4 GeV (Spec energy) beam to the first of its three experimental halls to come on-line.

Thomas Jefferson National Accelerator Facility

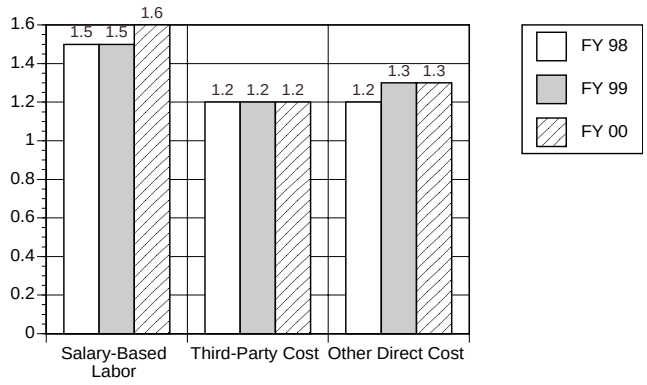
Major Partnerships, Collaborations, and Cooperative Research and Development Agreements

Category/Mission	*Partner*	*Description*
Science & Technology	User Community	Jefferson Lab user community, currently over 1600 users from 280 institutions and 36 countries. Nuclear physics; Free Electron Laser
	Universities	Universities, including minority institutions, with an emphasis on the Southeastern region. Nuclear physics; medical diagnostics; Free Electron Laser
	National Science Foundation	Nuclear physics
	NASA	Detectors
	ORNL, LANL, BNL, ANL, LBNL	Basic Energy Sciences: Spallation Neutron Source
	Brookhaven National Lab	Free Electron Laser
	Commonwealth of Virginia	Nuclear physics; Free Electron Laser
	Center for Innovative Technology	Nuclear physics; Free Electron Laser
	Industries of the Laser Processing Consortium	Free Electron Laser
National Security	DOD/U.S. Navy/Air Force	Free Electron Laser

Performance Metrics (Normalized Data)



Cost Multipliers



NOTE: Financial metrics and cost multipliers reveal performance trends at individual laboratories. Comparisons between laboratories are inappropriate due to differences in laboratory accounting systems allowed by contract arrangements between DOE and individual laboratories.

R&D Activity: Oil and Gas Exploration and Production

DOE Programs

Program: Fossil Energy

Office: Office of Natural Gas and Petroleum Technology

DOE Laboratory Performers

Principal Laboratories: None

Contributing Laboratories: None

Participating Laboratories: LLNL, ANL, PNNL, BNL, INEEL, LBNL, LANL, ORNL, SNL

Strategic Goals and Objectives

Reduce the vulnerability of the U.S. economy to disruptions in oil supply (by stabilizing domestic production); Increase domestic energy production in an environmentally responsible manner (by increasing domestic gas production and recovering oil with less environmental impact); Develop technologies that expand long term energy options (such as the production of gas from methane hydrates and deep gas formations).

Focus on enhancing the efficiency and environmental quality of domestic oil and natural gas exploration and production. Improved technology and information, focusing on high-risk technology that private companies alone won't undertake, are required to boost production of natural gas, a clean and abundant domestic fossil fuel that is an increasingly important component of our Nation's energy portfolio, and to extend the life of domestic oil fields, many of which are marginally economic and operated by independent producers. Technology advances leading to more cost-effective recovery of domestic oil and gas, particularly from geologically complex deeper reservoirs, will enable domestic producers to continue exploring for and recovering oil and gas from reservoirs that would otherwise be economically unviable, and will help to maintain reliable domestic supplies of these vital fuels at competitive prices.

R&D Activities

Diagnostics and Imaging (AC1005, AB0540) - Supports the development and use of advanced technologies for reservoir characterization and risk based decision making, preserves and provides access to subsurface data, and develops analytical tools to perform the analyses required for accurately quantifying oil and gas resources and reserves.

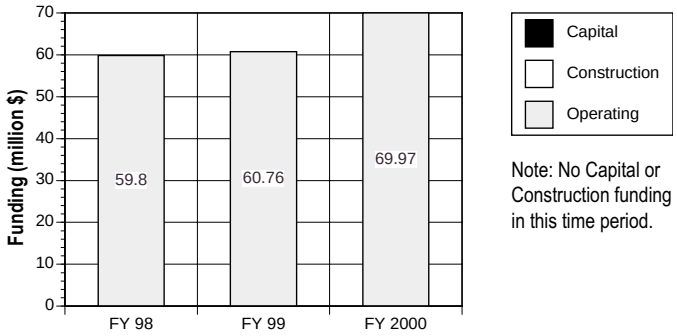
Drilling Completion and Stimulation (AC1005, AB0540) - Focuses on the development of sophisticated technologies and methodologies that can encourage investments in producing new oil and gas plays, and that can increase production from existing plays.

Reservoir Life Extension (AC1010, AB0540) - Supports the development of innovative and cost-effective technologies that can extend the productive life of domestic reservoirs, and facilitates their transfer to producers, in order to slow the rate of premature abandonment of U.S. oil and gas wells and reduce our reliance on energy imports.

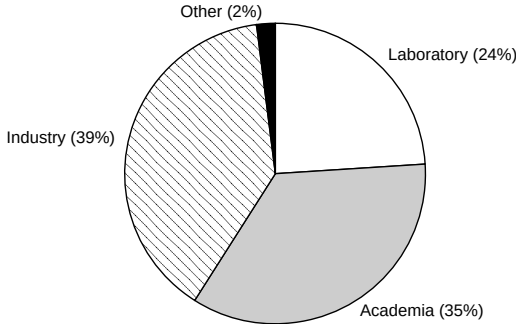
Drilling and Production Environmental Management (AC1015, AB0555) - Pursues improvements to the regulatory process, supports development of new technologies, and exercises key responsibilities for energy policies that encourage efficient recovery and ensure adequate secure energy supplies.

Gas Hydrates (AB0540) - Produces the knowledge and technology necessary for commercial production of methane from hydrates by 2015 and addresses associated environmental and safety issues.

Funding History

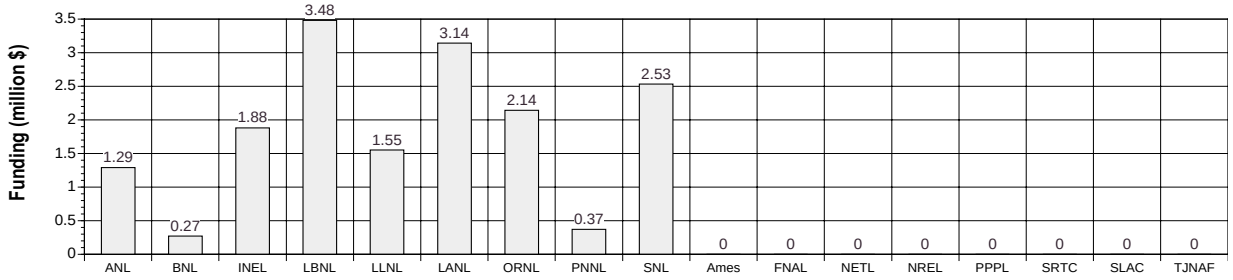


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Energy Resources | **Strategic Goal: Reliable and Diverse Energy Supply**

Program Area: Enhancing Domestic Supplies

R&D Activity: Oil and Gas Processing

DOE Programs

Program: Fossil Energy

Office: Office of Natural Gas and Petroleum Technology

DOE Laboratory Performers

Principal Laboratories: None

Contributing Laboratories: ORNL

Participating Laboratories: BNL, ANL, INEEL, LBNL, LLNL, LANL, PNNL, SNL

Strategic Goals and Objectives

Increase domestic energy production by increasing domestic gas production, recovering oil with less environmental impact, and developing cost-effective renewable technologies.

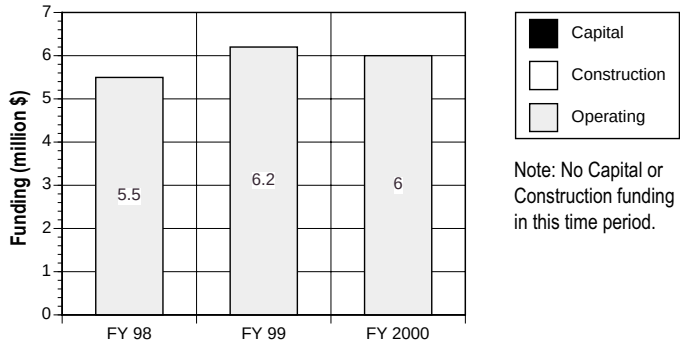
- Advance technologies and processes that will enable gas reserves with high contaminant levels to be upgraded to market specifications using gas purification technologies.
- Research advanced processes to collect and utilize the methane released during underground coal mining to harness this greenhouse gas and prevent it from being vented into the atmosphere.
- Maximize industry processing and utilization of U.S. oil resources by reducing the cost of effective environmental protection
- Develop technology to economically refine crude oil supplied to refineries that is becoming heavier with more sulfur, nitrogen, and heavy metals, in an evironmentally sound manner
- Develop technology to process heavy crude oil into high-value products rather than high levels of low value residual oils, coke byproducts, and wastes.
- Provide sound science and develop fundamental scientific data to facilitate the development of effective refining technologies to prevent pollution formation.

R&D Activities

Specific activities in oil and gas processing (AB0550 and AC1015) include:

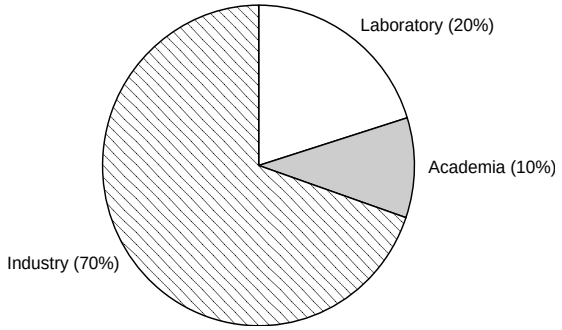
- Develop and screen organic and inorganic membranes that have high component selectivity and overall gas throughput to separate gas components.
- Research gas-contaminant absorption and adsorption systems that have rapid regeneration capability.
- Demonstration available methods to economically collect and utilize coal mine methane by focusing on producing methane for pipeline sales, small-scale electric power generation, and other uses.
- In coordination with EPA and industry, conduct research to produce data about origin and formation of fine particulate (PM2.5) at U.S.refineries so that proposed regulations will be based on sound science.
- Identify various pollutants present in petroleum and develop technology to prevent there formation during processing.
- Conduct research and development activities on the use of biotechnolgy to upgrade high sulfur, heavy crude oil into a more desirable low sulfur, light oil that would be easier to process.

Funding History



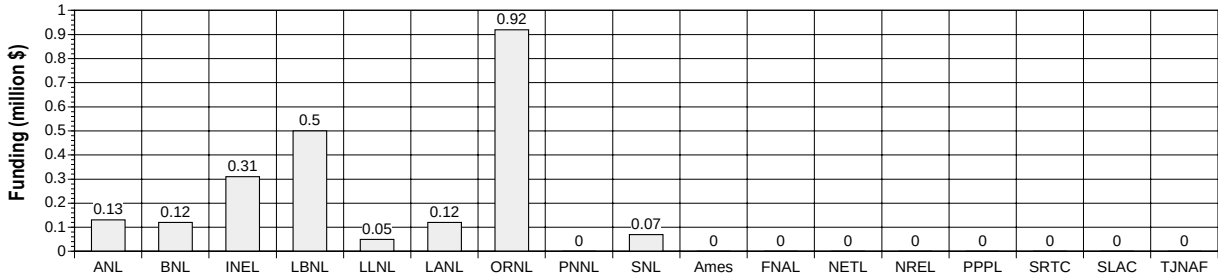
Note: No Capital or Construction funding in this time period.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Energy Resources | **Strategic Goal: Reliable and Diverse Energy Supply**

Program Area: Producing Clean Fuels

R&D Activity: Coal-Derived Fuels

DOE Programs

Program: Fossil Energy, Transportation Fuels and Chemicals, Solid Fuels and Feedstocks, Advanced Fuels Research, Steelmaking

Office: Office of Coal and Power Systems
Office of Coal Fuels and Industrial Systems

DOE Laboratory Performers

Principal Laboratories: NETL
Contributing Laboratories: None
Participating Laboratories: SNL

Strategic Goals and Objectives

Promote Reliable, Affordable, Clean and Diverse Domestic Fuel Supplies (ER1)

- Develop technology to produce ultra-clean transportation fuels from coal, natural gas, and other carbonaceous feedstocks for use in advanced PNGV and heavy trucks to achieve significantly reduced regional and global emissions
- Develop technology to produce environmentally preferred feedstocks from coal, coal wastes, and biomass

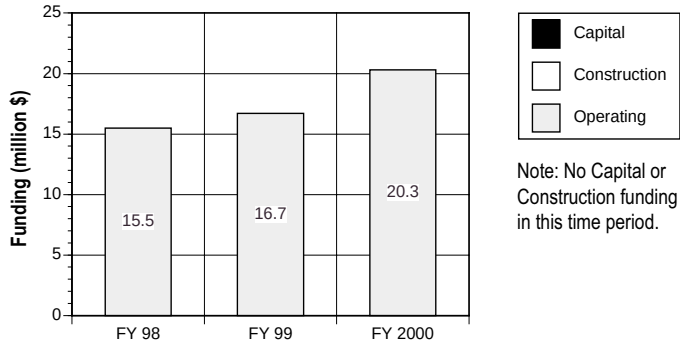
Promote Reliable, Affordable and Clean Transformation of Fuel Supplies into Electricity and Related Products (ER2)

- Develop advanced technology for the conversion of coal, petcoke or other carbonaceous feedstocks to produce electricity and other copducts such as ultra-clean transportation fuels and chemicals

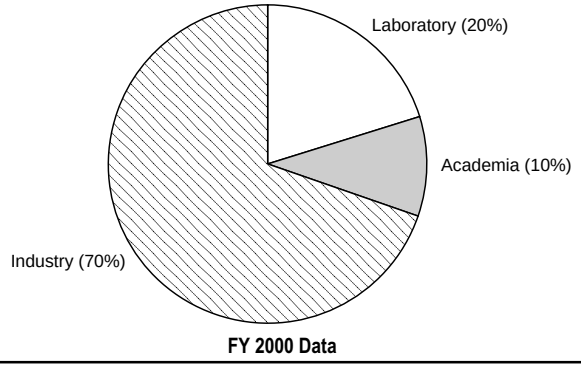
R&D Activities

- Conduct research and development (catalyst research, reactor development, product upgrading, like cycle analysis) for producing ultra-clean transportation fuels from coal-derived synthesis gas (B&R 1035)
- Conduct feasibility and supporting research for coproducing electricity, ultra-clean transportation fuels and chemicals from coal (B&R 1035)
- Conduct technology development for producing premium carbon products from coal (B&R 1005)
- Conduct technology development for producing environmentally preferred solid feedstocks from coal, coal waste in combination with biomass (B&R 1005)
- Conduct advanced fuels science research to improve our understanding leading to highly efficient, near zero emissions fuels (B&R 1020)

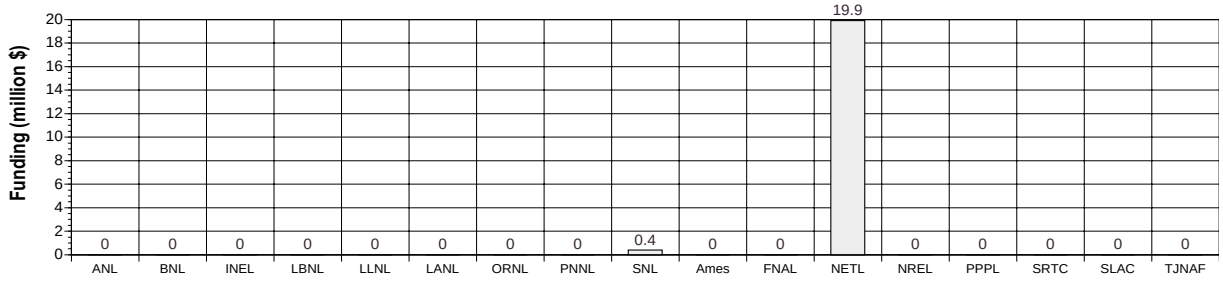
Funding History



Laboratory-Academia-Industry Participation



Fiscal Year 2000 Funding Profile



R&D Activity: Natural Gas to Liquids

DOE Programs

Program: Fossil Energy
Office: Office of Natural Gas and Petroleum

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: None
Participating Laboratories: BNL, INEEL, LANL, PNNL, SNL

Strategic Goals and Objectives

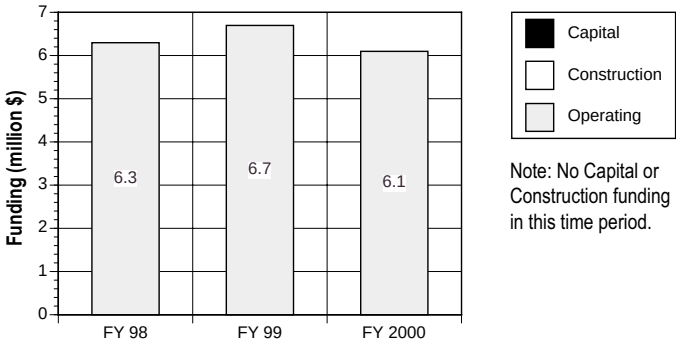
- The Natural Gas to Liquids R&D area supports the following Comprehensive National Energy Strategy (CNES) goals and objectives:
  - CNES Goal II, Objective 1 - Reduce the vulnerability of the U.S. economy to disruptions in oil supply.
  - CNES Goal III, Objective 1 - Increase domestic energy production in an environmentally responsible manner (transportation applications).
- Develop, for deployment by 2008, breakthrough technology to convert unmarketable Alaskan and other remote natural gas to high quality, cleaner transportation fuels and produce premium chemicals at costs 25 to 35 percent below current technology
- Enable gas-to-liquids products to be a potentially large source of fuels suitable for advanced, high-mileage, low emissions vehicle engines, liquids derived from natural gas

R&D Activities

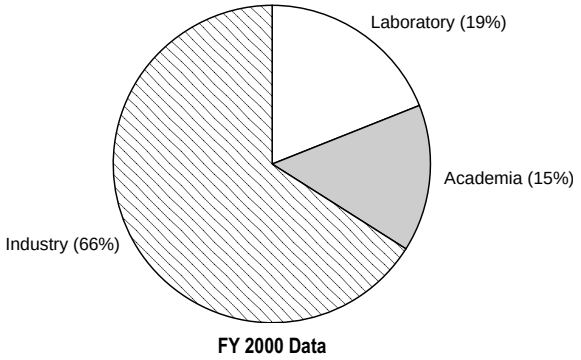
B&R = AB0550 ($1.20 million)

- Complete material, seal and reactor develpoment, and preliminary reactor design of novel ceramic membrane technology systems for the conversion of natural gas to syngas
- Monitor and evaluate gas-to-liquids feasibility factors for remote gas in Alaska, Gulf of Mexico and other domestic locations as stand-alone operations and/or with other power or energy conversion technology
- Conduct exploratory research activities of novel converion concepts

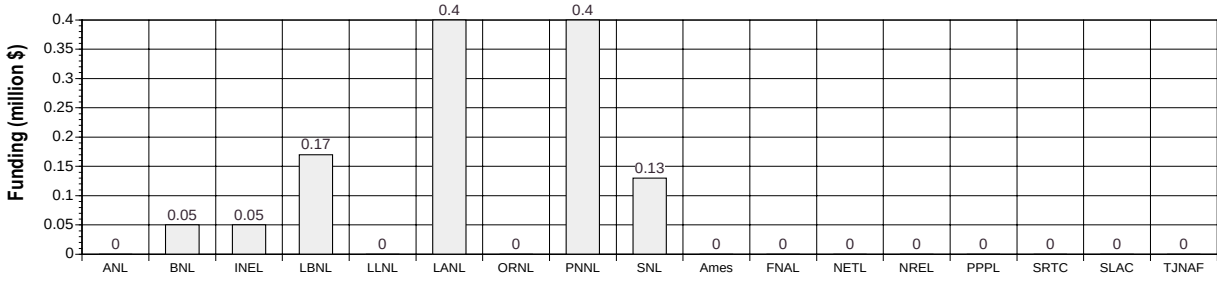
Funding History



Laboratory-Academia-Industry Participation



Fiscal Year 2000 Funding Profile



Program Area: Producing Clean Fuels

R&D Activity: Petroleum-Derived Fuels

DOE Programs

Program: Fossil Energy
Office: Office of Natural Gas and Petroleum Technology

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: None
Participating Laboratories: None

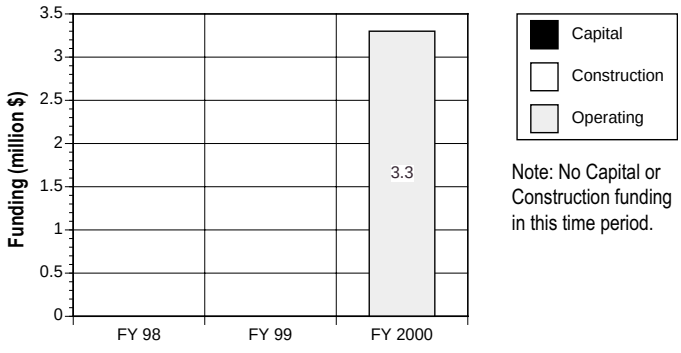
Strategic Goals and Objectives

- The Petroleum-Derived Fuels R&D area supports the following Comprehensive National Energy Strategy (CNES) goal and objective:
  - CNES Goal III, Objective 1 -- Increase domestic energy production in an environmentally responsible manner by increasing yield of valuable products from low-value Western hemisphere crudes decreases imports and increases value or production of these heavy crude feedstocks.
- The objective of this program is to evaluate the potential for using bioprocessing to remove sulfur from diesel fuel at a small refinery in Alaska to possibly assist small refiners meet EPA proposed Tier 2 fuel-sulfur specifications.

R&D Activities

- Solicit proposals from small refiners in Alaska and select a contractor.
- Conduct research to provide data to validate viability of biodesulfurization of diesel fuel for application in small refineries.

Funding History



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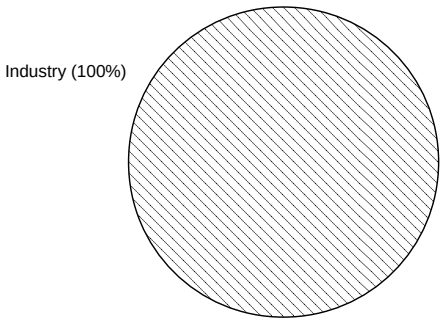
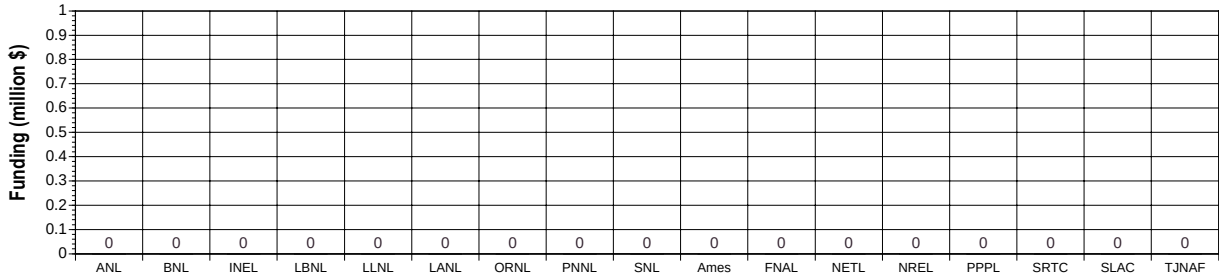


FY 2000 Data

Fiscal Year 2000 Funding Profile



R&D Activity: Advanced Coal Gas and Combustion Systems

DOE Programs

Program: Fossil Energy
Office: Office of Coal and Power Systems
Office of Power Systems, Office of Advanced Research

DOE Laboratory Performers

Principal Laboratories: NETL
Contributing Laboratories: None
Participating Laboratories: LANL, PNNL, INEEL, SNL, ORNL

Strategic Goals and Objectives

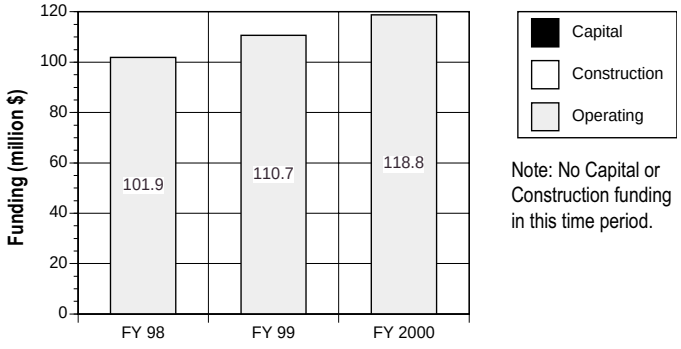
- Support competitive and efficient electric systems.
- Ensure energy system reliability, flexibility, and emergency response capability.
- Increase domestic energy production in an environmentally responsible manner.
- Accelerate development and market adoption of environmentally friendly technologies.
- Develop technologies that expand long-term energy options.
- Promote development of open, competitive, international energy markets, and facilitate the adoption of clean, safe, and efficient energy systems.

R&D Activities

Develop advanced coal gas and combustion systems, fuel cells, advanced turbine systems, and carbon sequestration systems.

- B&R AA2015 - Highly Efficient Integrated Gasification Combined Cycle
- B&R AA2005 - Low Emission Boiler System
- B&R AA2010 - Indirect-Fired Cycles
- B&R AA1500 - Advanced Research
- B&R AA3010 - Carbon Sequestration
- B&R AB056000 - Advanced Turbine Systems
- B&R AA2500 - Fuel Cell Systems

Funding History



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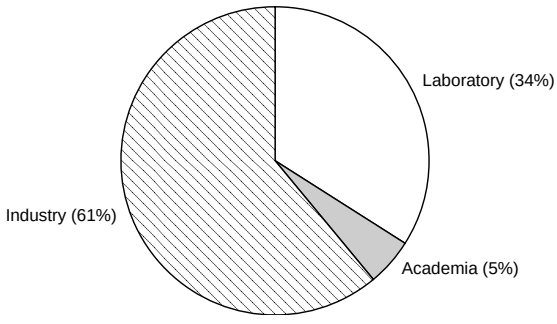

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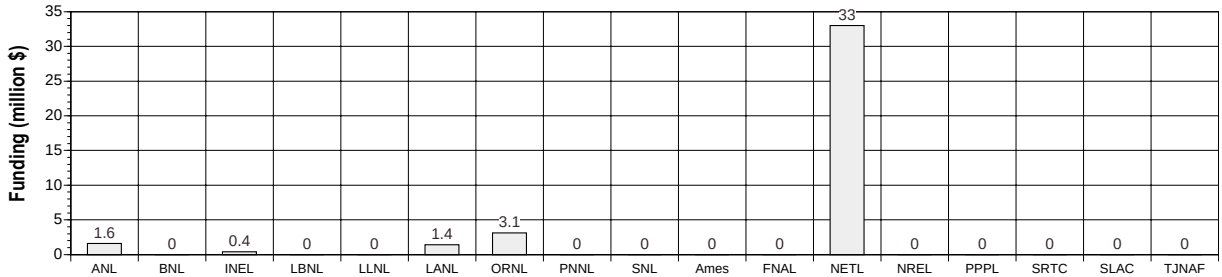
Fiscal Year 2000 Funding Profile



R&D Activity: Advanced Gas Turbines

DOE Programs

Program: Fossil Energy
Office: Office of Coal and Power Systems Turbines

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: None
Participating Laboratories: ORNL, NETL

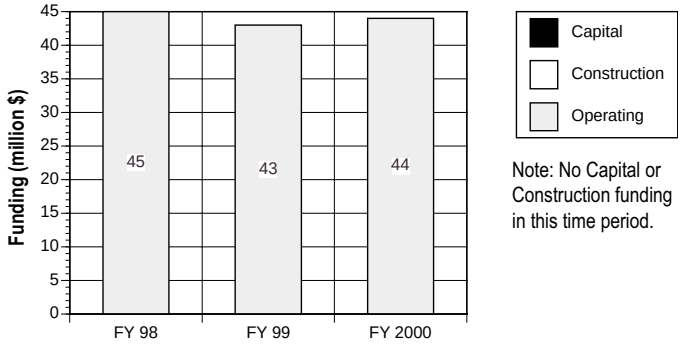
Strategic Goals and Objectives

- Support competitive and efficient electric systems.
- Ensure energy system reliability, flexibility, and emergency response capability.
- Increase domestic energy production in an environmentally responsible manner.
- Accelerate development and market adoption of environmentally friendly technologies.
- Develop technologies that expand long-term energy options.
- Promote development of open, competitive, international energy markets, and facilitate the adoption of clean, safe, and efficient energy systems.

R&D Activities

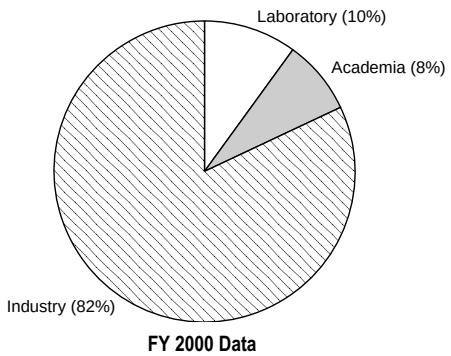
- B&R AB056000 for all activities.
- Develop 60% net thermal efficiency utility gas turbines with NOx emissions less than 9ppm and cost 10 to 20% lower than 1991 systems.
- Gas turbine combustion research conducted at NETL combustion facilities.
- University research in gas turbine combustion, aerodynamics, heat transfer and materials, directed by South Carolina Institute for Energy Studies on Campus of Clemson University. 95+ universities are participating.
- Advanced materials casting methods being developed to produce better quality and higher yields for gas turbine hot gas path components. Managed by NETL and Oak Ridge National Lab.
- Gas turbine combustion, aerodynamics, heat transfer and materials research conducted through several Small Business Innovative Reseach (SBIR) awards.
- Initiate Next Generation Turbine program to study flexible gas turbine systems, RAM (Reliability, Availability and Maintainability) improvements, and crosscutting R&D.

Funding History



Note: No Capital or Construction funding in this time period.

Laboratory-Academia-Industry Participation



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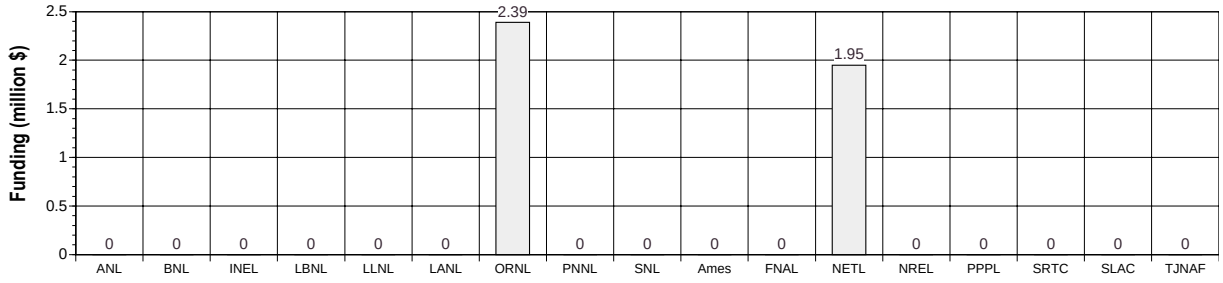


R&D Activity: Fuel Cells

DOE Programs

Program: Fossil Energy
Office: Office of Coal and Power Systems, Fuel Cell Systems

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: None
Participating Laboratories: ANL, ORNL, PNNL, NETL

Strategic Goals and Objectives

- Support competitive and efficient electric systems.
- Ensure energy system reliability, flexibility, and emergency response capability.
- Increase domestic energy production in an environmentally responsible manner.
- Accelerate development and market adoption of environmentally friendly technologies.
- Develop technologies that expand long-term energy options.
- Promote development of open, competitive, international energy markets, and facilitate the adoption of clean, safe, and efficient energy systems.

R&D Activities

AA 2510

- Commercialize one molten-carbonate fuel cell.
- Initiate a Solid State Energy Conversion Alliance Program to realize the low-cost potential of fuel cells.

AA 2535

- Commercialize one solid-oxide fuel cell DG hybrid system.
- Continue a long-term hybrid program in support of Vision 21.

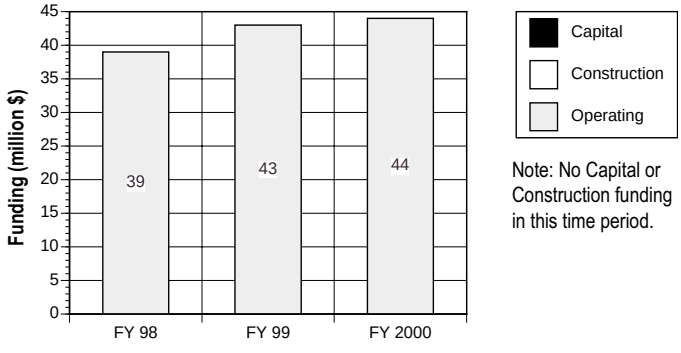
AA 2525

- Fund long-term R&D at national labs and universities for promising future fuel cell concepts.

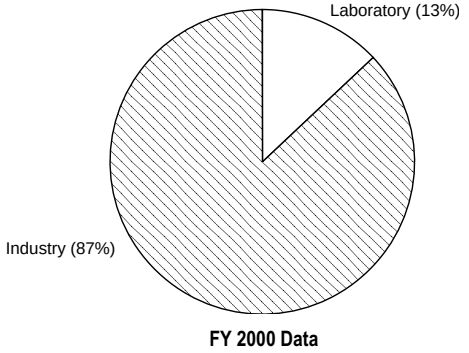
AA 2530

- Fund multi-layer ceramic fuel cell concepts with potentially substantially lower cost.

Funding History



Laboratory-Academia-Industry Participation



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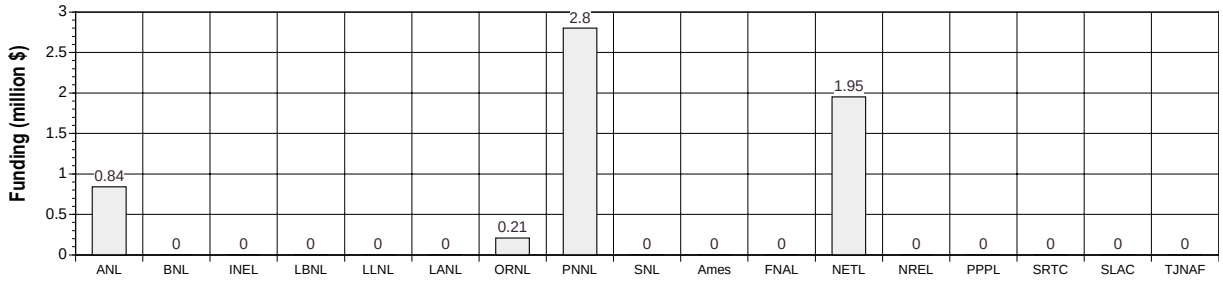


R&D Activity: Carbon Sequestration

DOE Programs

Program: Fossil Energy
Office: Clean Environmental Systems

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: None
Participating Laboratories: NETL

Strategic Goals and Objectives

Carbon Sequestration

- Provide economically competitive and environmentally safe options to offset all projected growth in baseline emissions of greenhouse gases by the U.S. after 2010 with offsets starting in 2015.
- Achieve the long-term cost goal of approximately $10/ton of avoided net costs for carbon sequestration.
- Offset at least one-half of the required reduction in global greenhouse gases, measured as the difference in a business-as-usual baseline and a strategy to stabilize concentration at 550 ppm CO2, beginning in 2025.

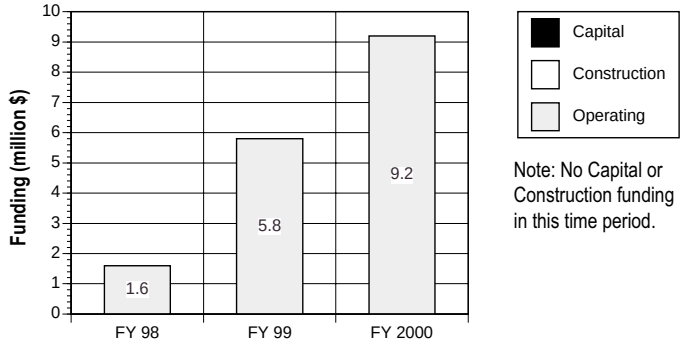
R&D Activities

B&R AA3010

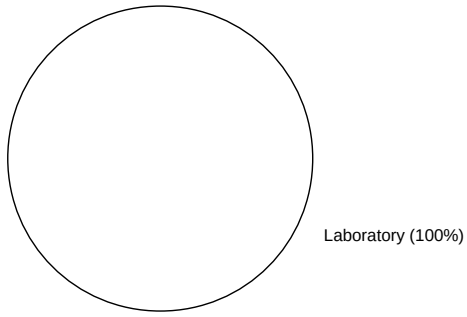
By 2015, demonstrate a suite of low-cost and environmentally-safe capture/sequestration technologies capable of offsetting all projected increases in U.S. greenhouse gas emissions.

- Drive down the costs of capture and separation of greenhouse gases from energy production and utilization process streams
- Establish the technical, environmental, and economic feasibility of carbon sequestration using a variety of storage sites and fossil-energy systems
- Determine the environmental aspects of large-scale CO2 storage
- Develop opportunities to integrate fossil energy production and utilization technologies with enhancement of natural sinks
- Develop innovative technologies that produce valuable commoditites from CO2
- Incorporate carbon sequestration processes into advanced energy production and utilization systems

Funding History



Laboratory-Academia-Industry Participation



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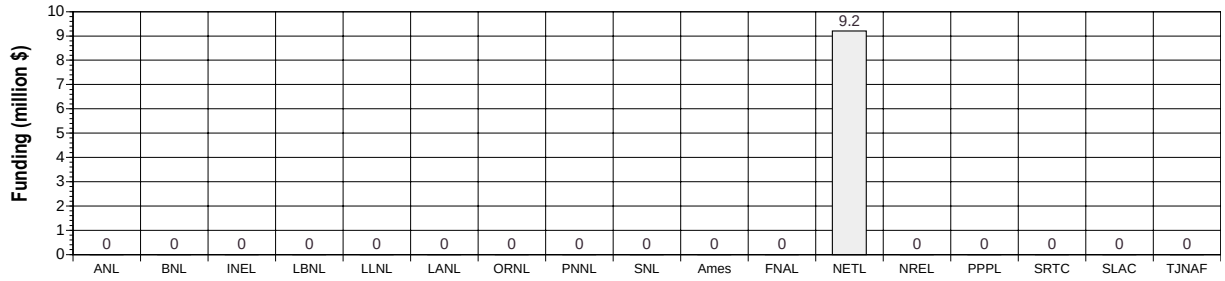
Fiscal Year 2000 Funding Profile



R&D Activity: Gassification Technologies

DOE Programs

Program: Fossil Energy
Office: Office of Coal and Power Systems
Office of Power Systems and Advanced Research

DOE Laboratory Performers

Principal Laboratories: NETL
Contributing Laboratories: None
Participating Laboratories: ANL, LANL, ORNL

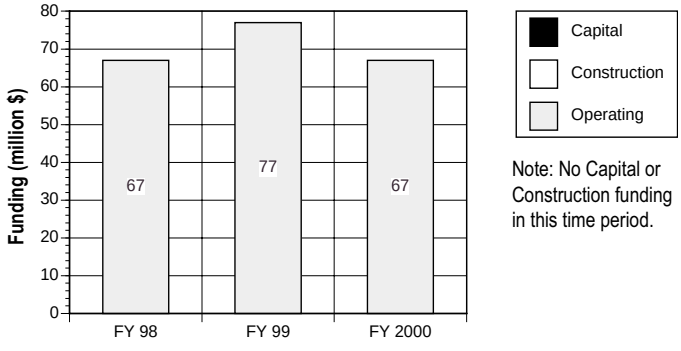
Strategic Goals and Objectives

- Support competitive and efficient electric systems.
- Ensure energy system reliability, flexibility, and emergency response capability.
- Increase domestic energy production in an environmentally responsible manner.
- Accelerate development and market adoption of environmentally friendly technologies.
- Develop technologies that expand long-term energy options.
- Promote development of open, competitive, international energy markets, and facilitate the adoption of clean, safe, and efficient energy systems.

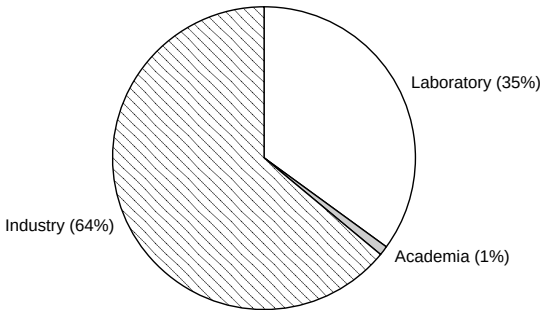
R&D Activities

- Strategic objective for Highly Efficient Integrated Gasification Combined Cycle (B&R code AA 2015) is to extend the superior environmental performance of gasification technologies beyond electric power generation to include market-based production of fuels and chemical products and to support the long-term Vision 21 needs. This activity supports research in advanced gasification, gas cleaning and conditioning, gas separations, and utilization of byproducts.
- The Combustion Systems Program encompasses three major technical activities:
  - Low Emission Boiler Systems (LEBS; B&R Code AA 2005), an advanced pulverized coal-fired system that provides superior performance through the integration of environmental controls with supercritical steam cycles.
  - Indirect-Fired Cycles (IFC; B&R Code AA 2010), which are high efficiency cycles that utilize a high-temperature air furnace (HITAF) to transfer the heat of combustion to a clean working medium (e.g., air), coal pyrolysis, and fuel gas cleanup to control pollutant emissions.
- Pressurized Fluidized-Bed Combustion (PFBC; B&R Code AA 2020) which affords high efficiency, low polluting systems to utilize multi-fuel feedstocks in the generation of electricity.
- Advanced Research crosscutting activities (B&R Code AA1500) in support of advanced power systems including:
  - Coal Utilization Science to provide experimental and theoretical investigations in modeling and simulations.
  - Biotechnology to develop bioprocessing methods for alternate fuels production and biological methods for controlling emissions.
  - University Coal Research grants to provide support from U.S.-based academic institutions in basic research to improve fossil energy technologies.

Funding History



Laboratory-Academia-Industry Participation



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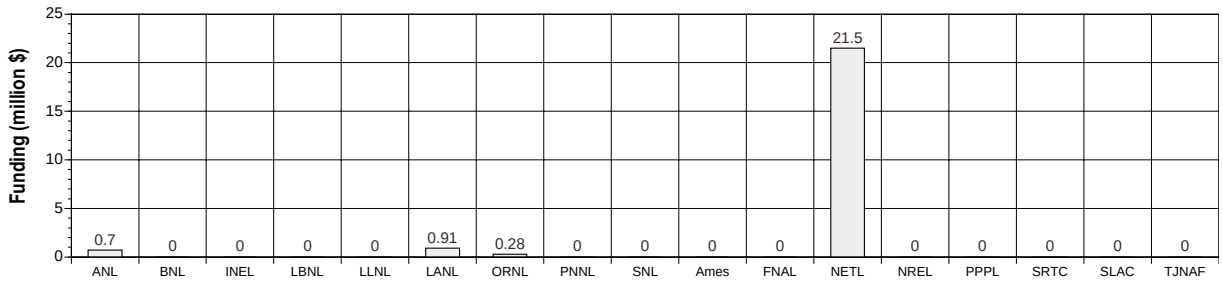


Energy Resources | **Strategic Goal: Clean and Affordable Power**

Program Area: Advanced Power Systems

R&D Activity: Technology Improvement of Operating Plants

DOE Programs

Program: Fossil Energy
Office: Office of Environmental Systems and Advanced Research

DOE Laboratory Performers

Principal Laboratories: NETL
Contributing Laboratories: ORNL
Participating Laboratories: ANL, INEEL, PNL, SNL

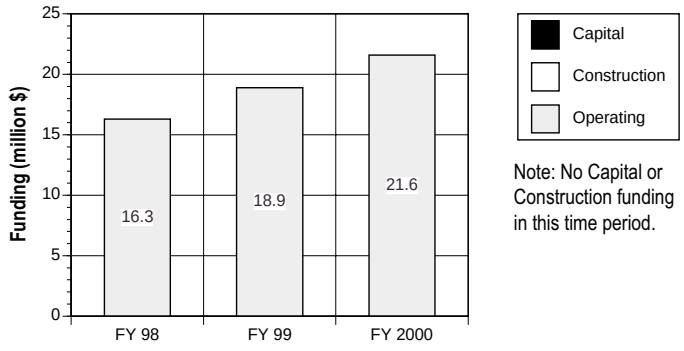
Strategic Goals and Objectives

- Support competitive and efficient electric systems.
- Promote development of open, competitive international energy markets, and facilitate the adoption of clean, safe, and efficient energy systems.

R&D Activities

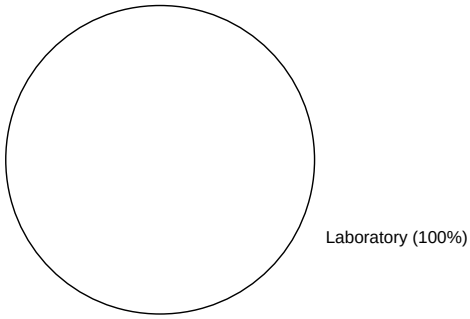
- Aging Effects in Key Components: develop improved materials and fabrication techniques, and conduct research to gain a better understanding of the combustion science, corrosion, and transport mechanisms that impact the life of components.
- Regulatory Compliance: (1) contribute to the science base of regulations and (2) develop emission control technology for major categories of pollution.
- Innovations for Existing Plants (B&R AA2025200):
  - Characterize ambient air quality and related fine particulate/air toxics emissions from fossil-fuel-based power production
  - Develop technology by 2005 for controlling NOx emissions to a level <0.15 lbs/million Btu at 3/4 the cost of selective catalytic reduction
  - Develop technology by 2005 for reducing mercury emissions by 50-70 percent at less than 1/2 current costs.
  - Develop technology by 2003 capable of achieving >99.99 percent capture of ultra-fine primary particulate matter.
  - Develop technology for achieving >90 percent acid gas emissions reduction by 2003
  - Initiate research to address clean water issues including cooling-water-intake structures and TMDL air-water interface
  - Develop new applications for CCB materials and provide data on their environmental acceptability.
- Advanced Research Materials (B&R AA15101):
  - Conduct exploratory research to improve performance or cost of existing power systems and advanced systems (V21).
  - Research areas include development of high temperature alloys and ceramic composits for advanced combustors, coatings and claddings, separation membranes, and solid state electrolyte systems.

Funding History



Note: No Capital or Construction funding in this time period.

Laboratory-Academia-Industry Participation



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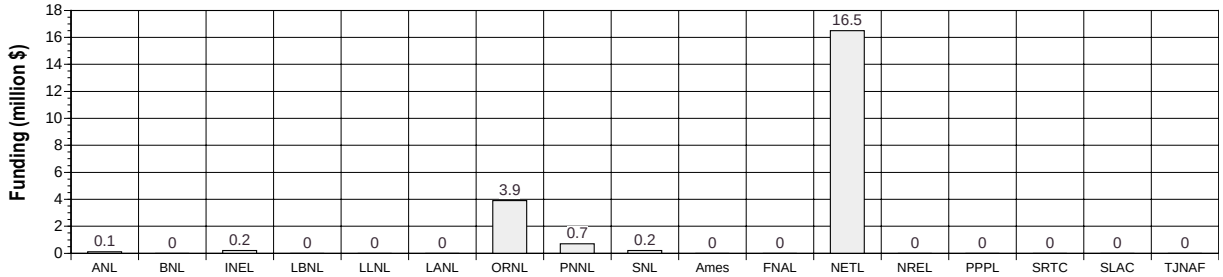


R&D Activity: Natural Gas Infrastructure

DOE Programs

Program: Fossil Energy
Office: Office of Gas and Petroleum Technology

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: LLNL, PNNL
Participating Laboratories: None

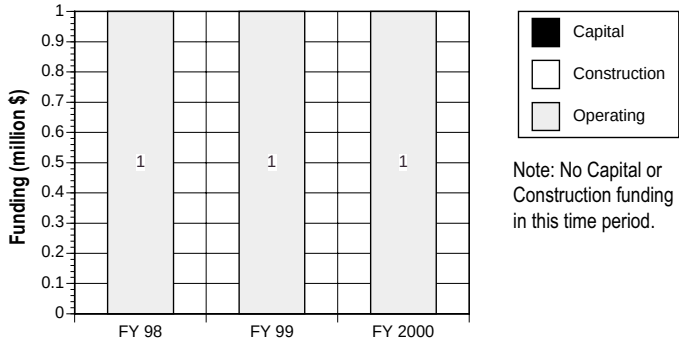
Strategic Goals and Objectives

- The naturalgas infrastructure R&D area supports the following Comprehensive National Energy Strategy (CNES) goals and objectives:
  - CNES Goal II, Objective 2 - Ensure energy system reliability, flexibility, and emergency response capability.
  - CNES Goal III, Objective 2 - Develop technologies tat expand long-term energy.
- The security, economic prosperity, and social well being of Americans depend on a complex system of interdependent energy infrastructures. The United Sates natural gas infrastructures while robust are facing operational challenges. The Department aims to advance technologeis and policies that provides industry with the tools to improve the gas system infrastructure and expand gas storage facilities to meet a 32 Tcf natural gas market by 2020.
- The program's efforts focus on technologies and policies to ensure pipeline infrastructure integrity, reliabiity, flexibility, and safety and efforts to improve gas storage deliverability, operational flexibility, and expand regional storage capacity.

R&D Activities

- Research related to delivery and storage including the gathering and transmission pipeline infrastructure and surface and subsurface gas storage facilities including:
- Specific R&D programs being implemented to accomplish these goals in Infrastructure (AB0545) are:
  - improved sensor development for monitoring and prevention of third party damage and outside force damange,
  - material research for pipeline life extension,
  - risk-managment integrity and safety model development,
  - streamline state and federal regulatory and environmental permitting process,
  - advanced storage technologies for growing industrial and power generation markets,
  - advance storage well deliverability enhancement and improved remediation treatments to offset deliverability losses,
  - re-engineering underground storage reservoirs to increase operational flexibility,
  - improved real-time storage measurement technologies and gas flow metering , and
  - pipeline energy measurement technologies,

Funding History



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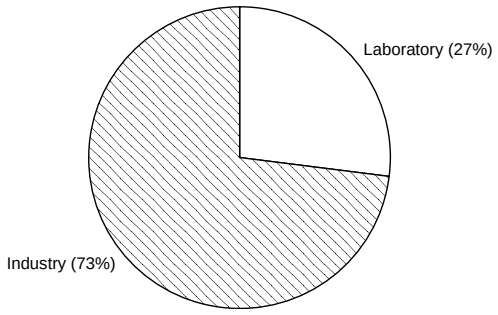
Laboratory-Academia-Industry Participation



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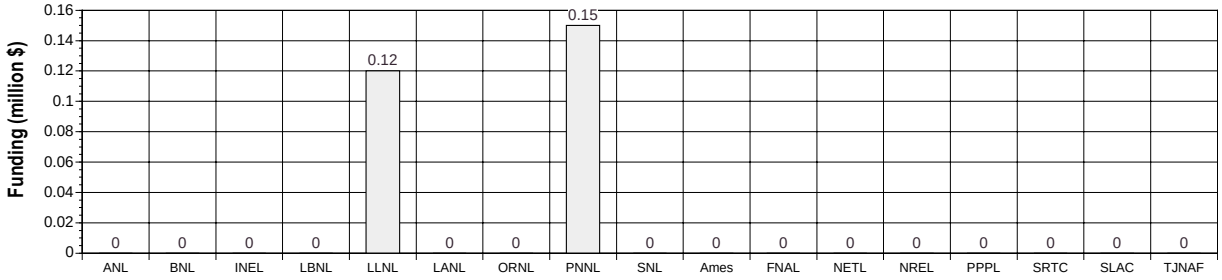


Energy Resources | **Strategic Goal: Clean and Affordable Power**

Program Area: Enhancing Energy Systems Reliability

R&D Activity: Secure Energy Infrastructure

DOE Programs

Program: Critical Infrastructure Protection
Office: Office of Critical Infrastructure Protection (SO-50)

DOE Laboratory Performers

Principal Laboratories: ANL, PNNL
Contributing Laboratories: LANL, SNL
Participating Laboratories: LLNL

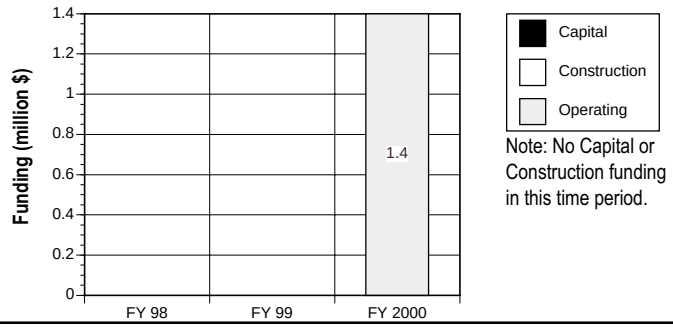
Strategic Goals and Objectives

- Carry out DOE's role under PDD-63 as the lead Federal agency for the energy infrastructure.
- Ensure the continuity and viability of the Nation's critical energy infrastructures.
- Ensure the elimination of any significant vulnerability of the energy sector to physical and cyber disruptions.
- Leverage and develop essential energy infrastructure protection, mitigation, response, and recovery methodologies, analytic tools, and technologies.
- Collaborate with major stakeholders, including private sector owners of energy infrastructure elements, other Federal agencies, and state and local governments, to conduct research that will enhance the protection of the Nation's energy infrastructure from disruptions and develop methododogies, architectures, analytic tools, and technologies in (1) analysis and risk management and (2) protection and mitigation technologies.

R&D Activities

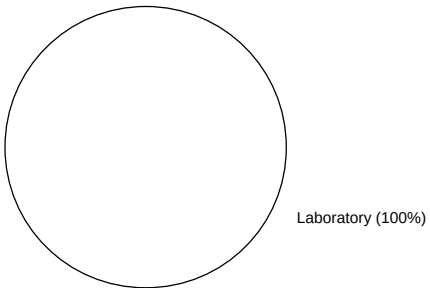
(All activities fall under B&R GD0509000.)
Infrastructure Interdependencies: Develop methodologies and tools to characterize interdependencies among energy infrastructures and with other critical infrastructures. Develop interdependence "tool set" to analyze the implications fo technology and policy decisions.
Vulnerability Assessments: Identify and evaluate the vulnerabilities of energy infrastructures (physical and cyber components) and develop best practices methodology for industry use.
Scale and Complexity Analysis: Research and characterize internal dynamics of large, complex, nonlinear infrastructure, focusing on stability, countermeasures, complexity reduction, uncertainty effects, and behavior.
Consequence Analysis and Management: Develop and leverage databases, methodologies, and tools to evaluate the public health and safety, national security, and economic consequences of infrastructure disruptions and processes for restoration and reconstitution.
Risk Management: Develop tools for cost-effective planning and implementation of critical infrastructure protection strategies.
Policy Effects and Institutional Barriers: Evaluate real and potential impacts of public policies on critical infrastructure protection policies and barriers.
Real-time Control Mechanism Technologies: Identify vulnerabilities of real-time control systems. Develop technologies to protect against unauthorized control of or intrusion into infrastructure control systems.
Integrated Multisensor and Warning Technologies: Develop integrated systems to warn of attacks and impending failures at critical nodes. Focus on anomaly detection and failure warning technologies.
Centers of Academic Excellence for Infrastructure Assurance: Develop systems engineering expertise necessary to address system complexities and interdependencies and identify and mitigate vulnerabilities.

Funding History



Note: No Capital or Construction funding in this time period.

Laboratory-Academia-Industry Participation



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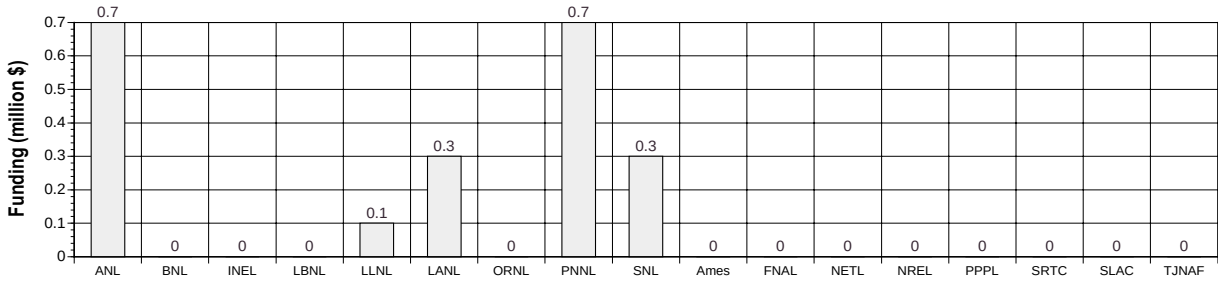


R&D Activity: Strategic Petroleum Reserve (SPR)

DOE Programs

Program: Fossil Energy
Office: Office of Strategic Petroleum Reserve

DOE Laboratory Performers

Principal Laboratories: SNL
Contributing Laboratories: NPTO
Participating Laboratories: NETL, ORNL

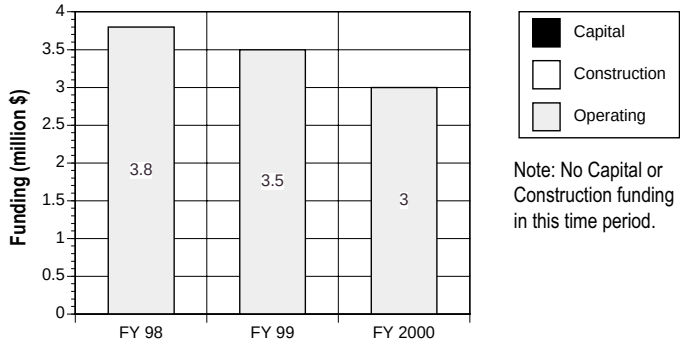
Strategic Goals and Objectives

- The Strategic Petroleum Reserve (SPR) is a large crude oil stockpile, under the control of the President of the United States
- The SPR is the Nation's first line of defense against an interruption in petroleum supplies
- SPR's mission is to reduce the adverse economic impact of a major petroleum supply interruption to the United States and International Energy Agency (IEA) allies
- SPR supports the DOE energy resources objective to promote reliable, affordable, clean and diverse domestic fuel supplies
- Maintaining an effective SPR, capable of storing 700 million barrels of crude oil, to deter and respond to energy supply disruptions, and cooperate with the member nations of the IEA is a key success element toward supporting this DOE objective
- Ensuring the readiness of the SPR to distribute crude oil within 15 days of Presidential notification is a second key success element
- Managing the SPR Program in an effective, efficient, safe, and environmentally sound manner is equally acknowledged as a key success element

R&D Activities

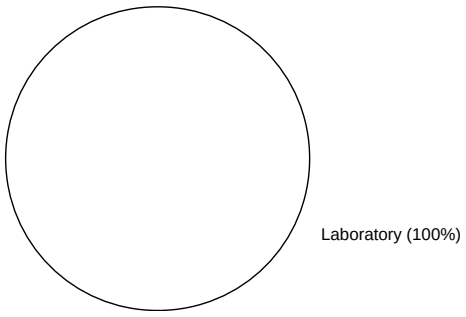
- The mission of the Reserve requires that each site and terminal be capable of transitioning from operational readiness to full drawdown within 15 days.
- This readiness requirement is supported in various ways by the efforts of DOE laboratories.
- SNL primarily provides geotechnical research support for the planning, design, development and monitoring of the SPR crude oil underground storage.
- NPTO serves as the analytical research laboratory, addressing the petroleum technology issues of the SPR's stockpile of crude oil, particularly oil quality.
- ORNL provides economic modeling analysis for perspective on issues like Reserve size and economic impacts of SPR drawdown.
- NETL FY 2000 support assisted SPR with appraisal expertise for its ongoing real estate operations related to leasing of underutilized facilities.

Funding History



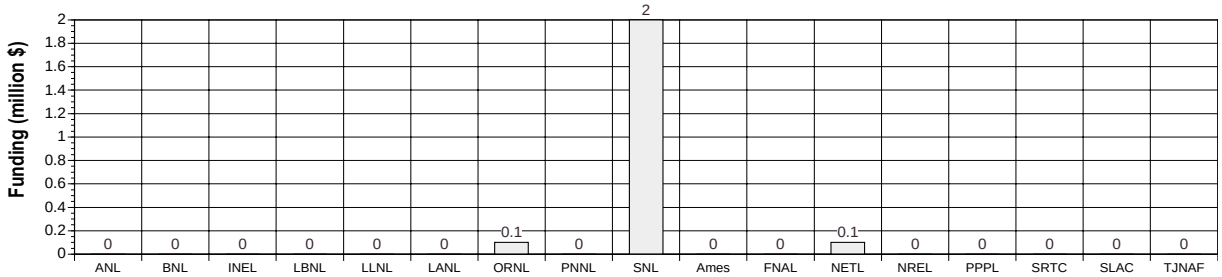
Note: No Capital or Construction funding in this time period.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



R&D Activity: National Nuclear R&D Infrastructure

DOE Programs

Program: Office of Nuclear Energy, Science and Technology
Office: FFTF, TRA Landlord, Termination

DOE Laboratory Performers

Principal Laboratories: Hanford/ANL
Contributing Laboratories: INEEL
Participating Laboratories: None

Strategic Goals and Objectives

Strategic Goal: Manage the nuclear facilities, isotopic inventories, and human resources that have been entrusted to NE
Objectives: Assure an adequate nuclear facility infrastructure for the 21st Century.

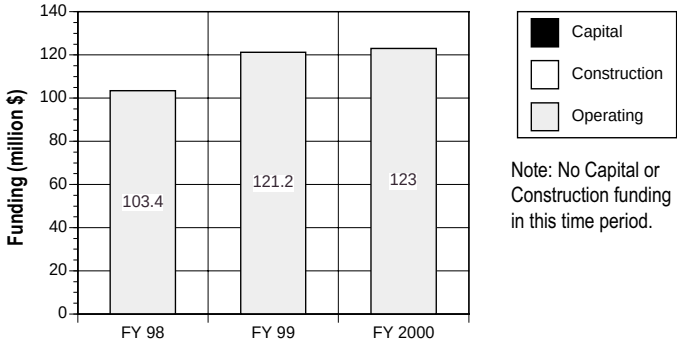
R&D Activities

Maintain the Fast Flux Test Facility. B&R# AF79 Total FY 2000 funding $37 million. These funds are expended under contractual arrangements made by the Richland Operations Office.

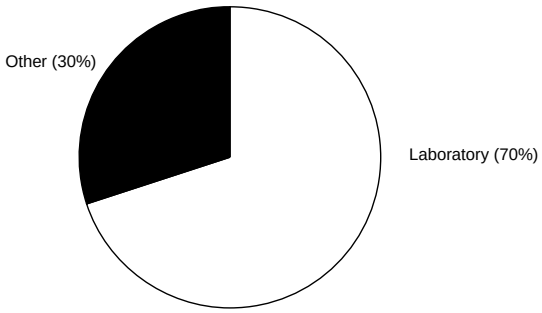
Continue the operation and maintenance of the Test Reactor Area in Idaho. B&R # AF40 FY 2000 funging $7.108 million.

Maintain and remediate legacy facilites B&R # AF95 FY2000 funding $78.775 million.

Funding History

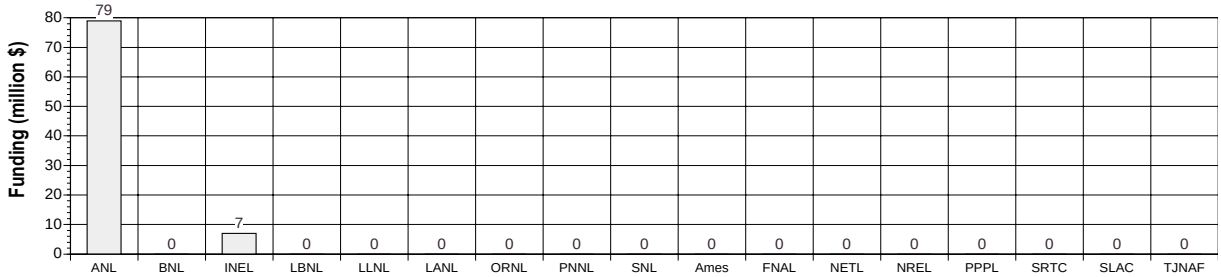


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Energy Resources | **Strategic Goal: Clean and Affordable Power**

Program Area: Nuclear Systems

R&D Activity: Isotope Research and Support

DOE Programs

Program: Office of Nuclear Energy, Science and Technology
Office: Isotope Support

DOE Laboratory Performers

Principal Laboratories: LANL
Contributing Laboratories: BNL, ORNL, SNL
Participating Laboratories: None

Strategic Goals and Objectives

Conduct nuclear medical research to broaden and improve the application, type, and effectiveness of nuclear medical therapies.

Provide a reliable supply of quality isotopes to our customers in industry, academia, and medical research.

R&D Activities

B&R# ST Total FY 2000 Funding: $19.5 million

Sponsor the Advanced Nuclear Medicine Initiative, a nuclear medical-science program that is peer-reviewed and competitively selected; provide financial assistance and isotopes to researchers.

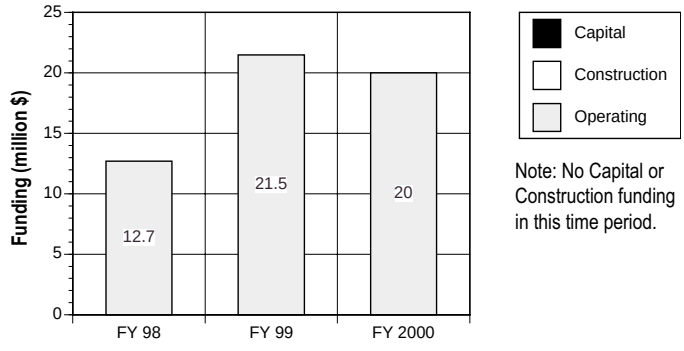
Encourage the training of individuals in nuclear medicine methods by establishing scholarships and fellowships for nuclear medicine specialists.

Invest in facilities and operations to maintain an average on-time delivery rate of 95 percent and ensure 98 percent of products meet or exceed customer specifications.

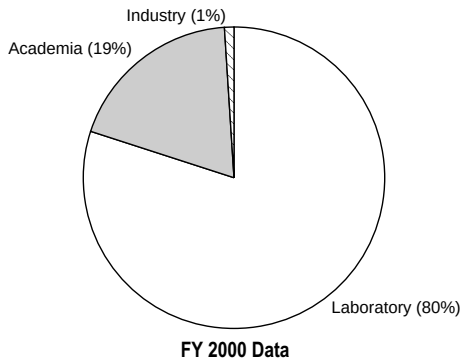
Achieve maximum private sector involvement in isotope activities by privatizing those with commercial potential.

Invest in innovative methods and technologies to make our medical and industrial research isotopes the best available.

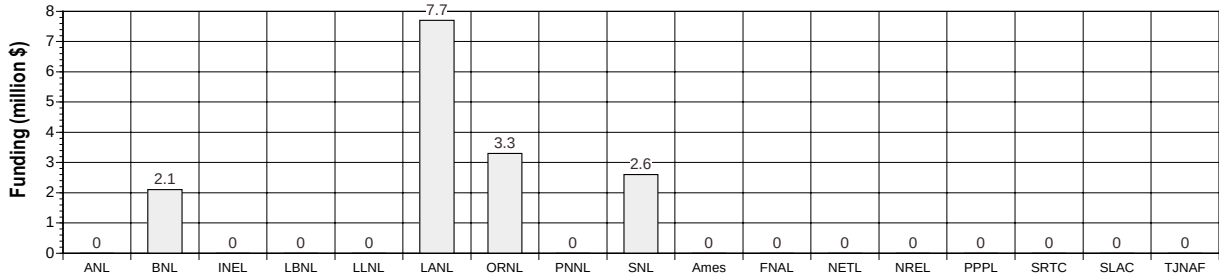
Funding History



Laboratory-Academia-Industry Participation



Fiscal Year 2000 Funding Profile



Energy Resources | **Strategic Goal: Clean and Affordable Power**

Program Area: Nuclear Systems

R&D Activity: University Nuclear Science and Reactor Support

DOE Programs

Program: Office of Nuclear Energy, Science and Technology
Office: University Nuclear Science and Reactor Support

DOE Laboratory Performers

Principal Laboratories: INEEL
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

Provide assistance to college nuclear engineering programs to foster academic excellence and improve university nuclear research and training facilities.

R&D Activities

B&R# AF40 Total FY 2000 Funding: $12 million

Provide reactor fuel and laboratory equipment assistance for university reactors.

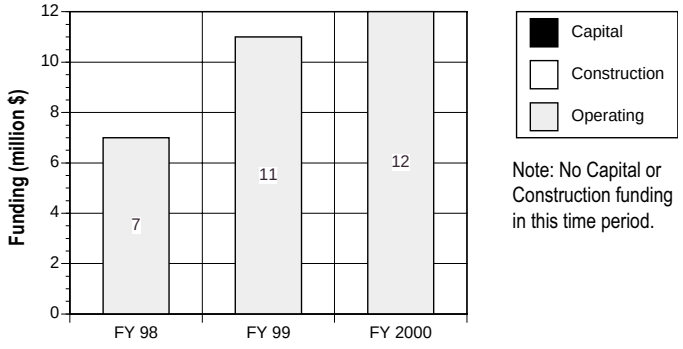
Provide grants and fellowships to support student scholarships and training and promote academic R&D.

Provide assistance for university recruitment and retention in nuclear engineering programs.

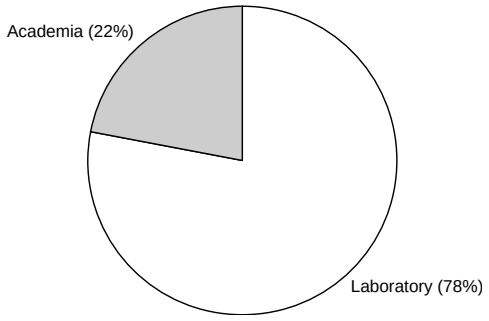
Provide a means to share reactor experimental laboratory facilities with colleges that do not have on-campus reactors and radiation laboratories.

Provide research and development funding for universities in the Establish a Blue Ribbon Panel to assess the role of university research reactors and what steps need to be taken to assure their availability.

Funding History

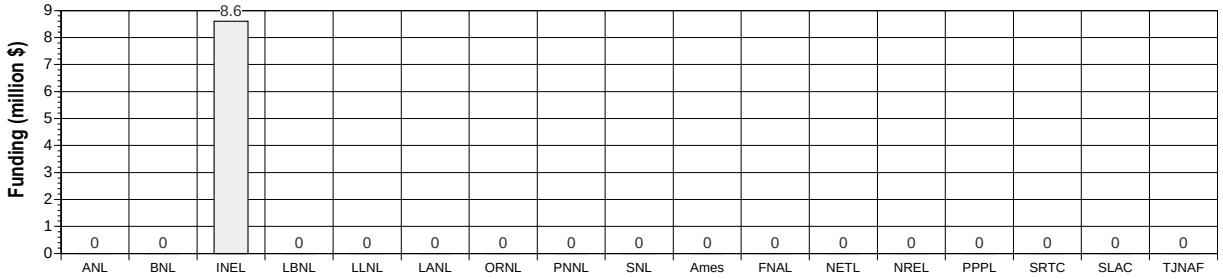


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



R&D Activity: Nuclear Energy Plant Optimization

DOE Programs

Program: Office of Nuclear Energy, Science and Technology
Office: NEPO

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: ANL, SNL
Participating Laboratories: LANL, ORNL, PNNL

Strategic Goals and Objectives

Goal: The goal of the Nuclear Energy Plant Optimization (NEPO) Program is to ensure that current nuclear plants can continue to deliver adequate and affordable energy supplies up to and beyond their initial 40-year license period by resolving open issues related to plant aging and by applying new technologies to improve plant reliability, availability, and productivity.

Objectives: Managing long-term effects of component aging: component and structural material degradation occurs in nuclear plants as a result of long-term operation and exposure of materials to harsh environmental conditions. Technology development under the NEPO Program will provide capabilities to easily prevent, detect, or repair the degradation.

Improving generation efficiency and productivity: Most current nuclear plants were designed and are operating with technologydeveloped over 25 years ago. As these nuclear plants age, components and parts degrade or become obsolete, introducing inefficiencies, added costs, and unreliability. NEPO focuses on improving the long-term economic performance of current plants through development of technologies that will improve equipment reliability, lower operating costs, and increase power output while maintaining high levels of safety.

R&D Activities

B&R# AF45 FY2000 Funding $4.976 million

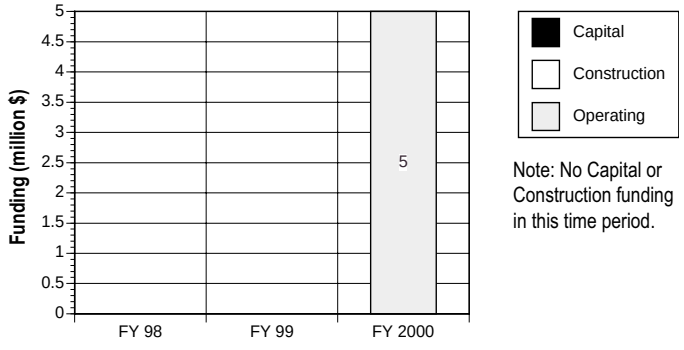
Development of technology for detection and characterization of defects in steam generator tubes.

Research and development on mechanical behavior of irradiated structural steel.

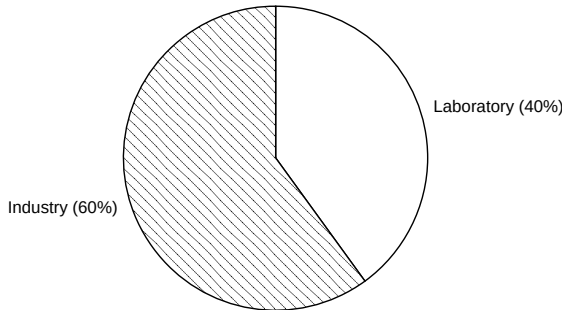
Assessment of natural aging effects on components.

Development and application of modern digital technology to replace obsolete analog systems.

Funding History

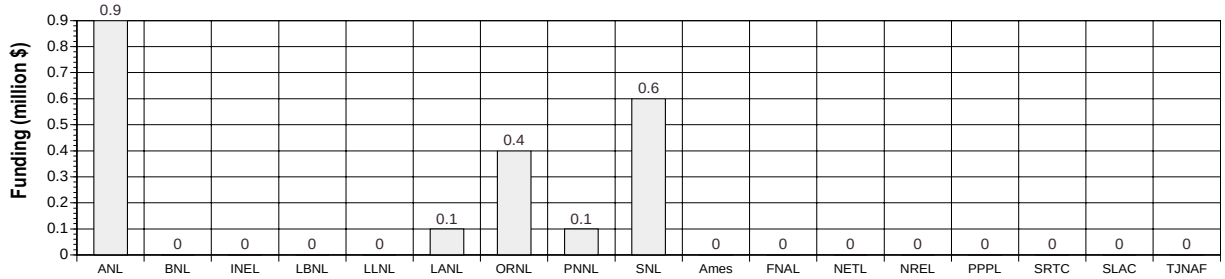


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Energy Resources | **Strategic Goal: Clean and Affordable Power**

Program Area: Nuclear Systems

R&D Activity: Civilian Research and Development

DOE Programs

Program: Office of Nuclear Energy, Science and Technology
Office: Advanced Accelerator Applications

DOE Laboratory Performers

Principal Laboratories: LANL, ANL
Contributing Laboratories: None
Participating Laboratories: BNL, LLNL, SNL

Strategic Goals and Objectives

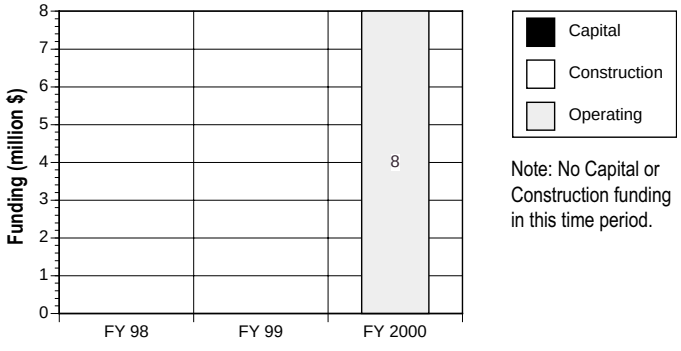
Develop advanced spent fuel treatment technologies that will reduce the volume of spent nuclear fuel and other radioactive waste that must be disposed.

R&D Activities

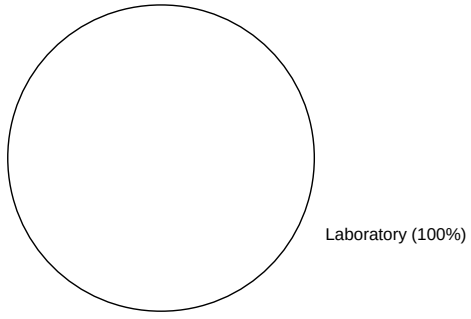
B&R# AF55 Total FY 2000 Funding: $8.5 million

Conduct a program aimed at determining the technical and economic feasibility of the Accelerator Transmutation of Waste (ATW) system. The ATW is intended to significantly reduce the volume of long-life radioisotopes in spent nuclear fuel.

Funding History

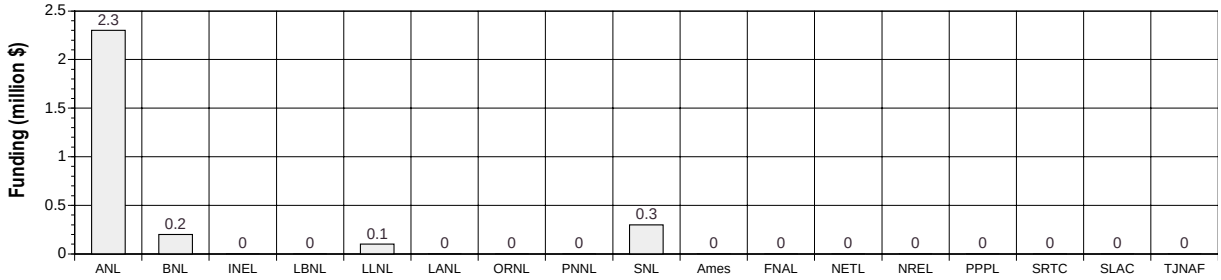


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



R&D Activity: Nuclear Energy Research Initiative

DOE Programs

Program: Office of Nuclear Energy, Science and Technology
Office: NERI

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: ANL
Participating Laboratories: BNL, INEEL, LLNL, LANL, ORNL, PNNL, SNL

Strategic Goals and Objectives

Develop advanced reactor and fuel cycle concepts and scientific breakthroughs in nuclear technology to overcome the principal scientific and technical obstacles to expand future use of nuclear energy in the United States, including issues involving nuclear material proliferation, unfavorable economics, and nuclear waste disposition.

Advance the state of U.S. nuclear technology to maintain a competitive position in overseas markets and a future domestic market.

Promote and maintain a nuclear science and engineering infrastructure to meet future technical challenges.

R&D Activities

B&R# AF35 FY 2000 funding $22.3million

Proliferation-Resistant Reactor and Fuel Cycle Technologies

Advanced High Efficiency Reactor Designs

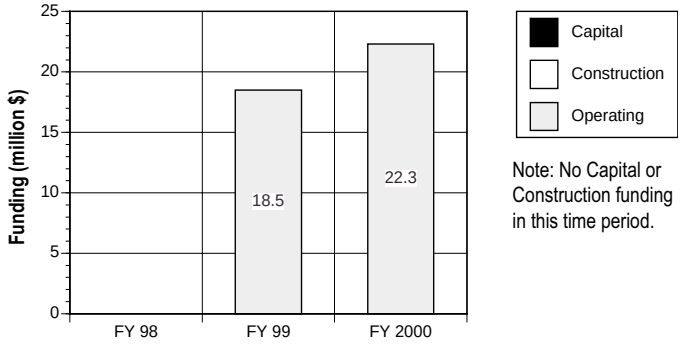
Advanced Low Power Reactor Designs and Applications

New Technologies for On-Site.and Surface Storage of Nuclear Waste

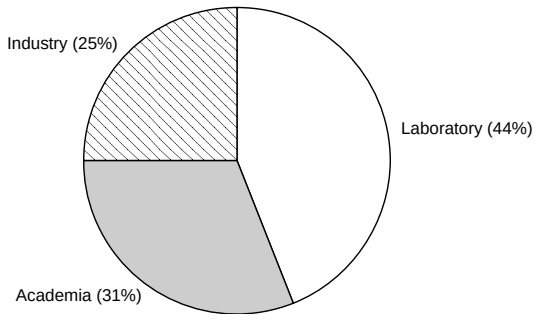
Advanced Nuclear Fuel

Fundamental Nuclear Science and Technology

Funding History

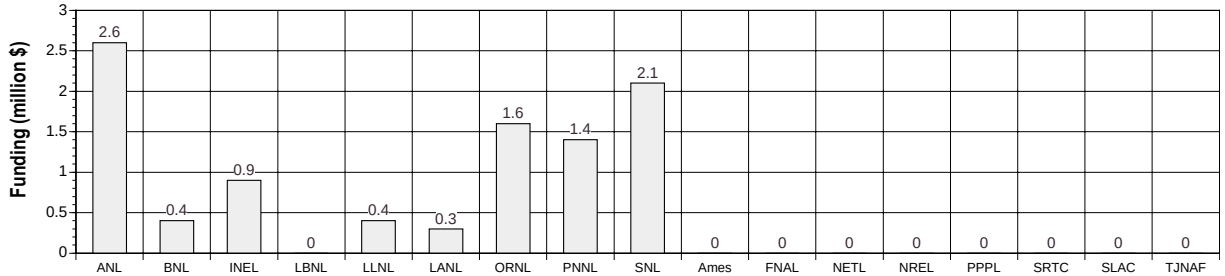


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



R&D Activity: Advanced Radioisotope Power Systems

DOE Programs

Program: Office of Nuclear Energy, Science and Technology
Office: Advanced Radioisotope Power Systems

DOE Laboratory Performers

Principal Laboratories: LANL
Contributing Laboratories: ORNL
Participating Laboratories: INEEL

Strategic Goals and Objectives

Develop improved nuclear energy conversion, power generation, and propulsion systems to enable future NASA exploration and space science missions.

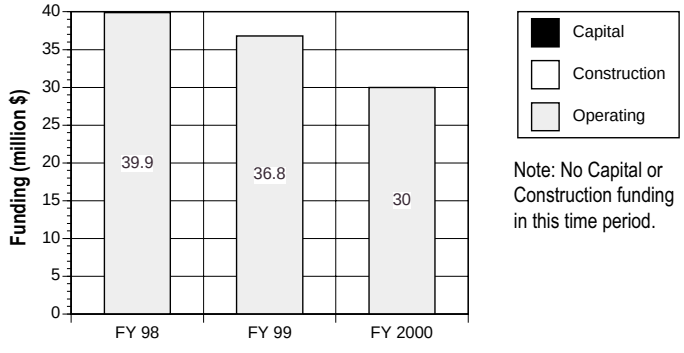
Provide compact, safe, nuclear power systems and related technologies to NASA, national security and other customers.

R&D Activities

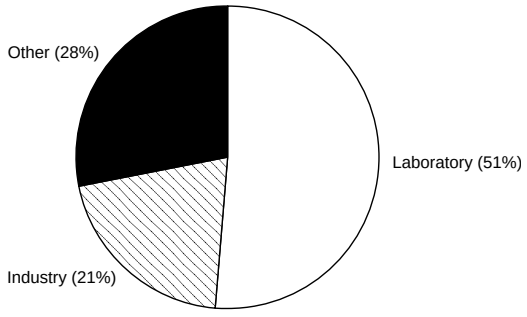
B&R# AF70 Total FY 2000 Funding: $29.8 milloin

- Conduct an assessment of special-purpose fission power technology to identify mission requirements, technology options, and projected design, development and testing costs and schedules that could be provided to NASA to assist in long-range planning efforts for future space exploration.
- Assess advanced conversion technologies to improve the efficiency of future nuclear power systems for space and national security missions.
- Develop an advanced radioisotope power system that is capable of providing greater than 20 percent thermal-to-electric conversion efficiency for potential deep space missions planned by NASA.
- Produce radioisotope thermoelectric generators, radioisotope heater units and other nuclear systems as needed for civilian and national security space missions.

Funding History

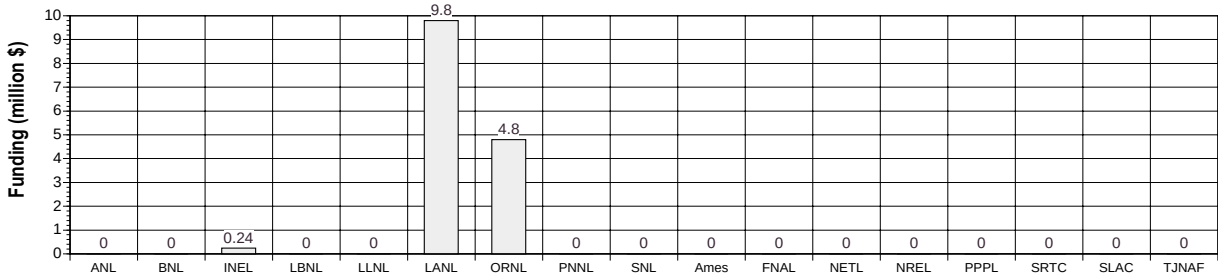


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Environmental Quality | **Strategic Goal: Management of Waste/Materials**

Program Area: Management of High-Level Waste

R&D Activity: Technology Development and Demonstration

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Technology Development and Demonstration

DOE Laboratory Performers

Principal Laboratories: ORNL, SRTC
Contributing Laboratories: INEEL, NETL, PNNL
Participating Laboratories: Ames, LANL, SNL

Strategic Goals and Objectives

- Solve environmental problems associated with the wastes in the underground storage tanks
  - Storage
  - Processing
  - Disposal

R&D Activities

Safe Waste Storage (B&R code: EW.40.10.00.0)
- Improve tank integrity monitoring and corrosion prevention to extend tank life, improve tank ventilation to reduce costs, improve waste characterization to support retrieval, and reduce the volume of waste entering the tank farm through source and recycle stream waste reduction.

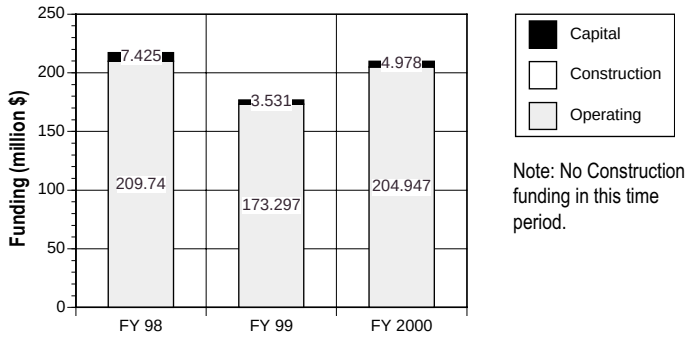
Retrieval (B&R code: EW.40.10.00.0)
- Mobilize and retrieve bulk and heel wastes (sludge and saltcake), detect and mitigate leaks during retrieval, transfer waste, and monitor and control retrieval processes.

Waste Pretreatment (B&R code: EW.40.10.00.0)
- Preparing retrieved waste for transfer and pretreatment, clarifying liquid streams through solid-liquid separations, supernate processing to remove radionuclides, sludge processing to remove excess chemical species that either increase the volume of HAW or adversely impact the performance of the HAW form. In addition, pretreatment addresses Interim Storage issues associated with INEEL's calcination and subsequent calcine dissolution.

Waste Immobilization (B&R code: EW.40.10.00.0)
- Develop product acceptance testing to ensure the LAW immobilization process produces an acceptable waste form, data collection to support performance assessment efforts, and evaluation of disposal site barrier technologies to ensure the final disposal of the immobilized LAW meets requirements.

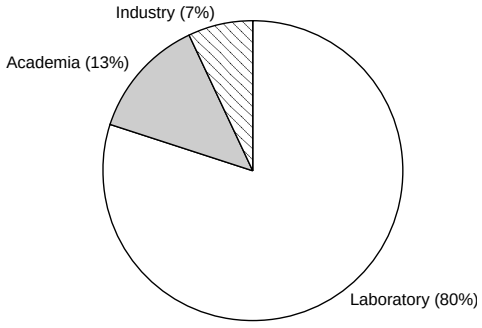
Tank Closure (B&R code: EW.40.10.00.0)
- Develop sampling and/or characterization of waste tank residuals, definition of and compliance with closure criteria (i.e., "how clean is clean?"), and stabilization of the tank "potentially including barrier technology." Stabilization of the tanks and installation of surface or subsurface barriers may be required following retrieval and post-retrieval characterization, to prevent subsidence of a tank, collapse of the domed top, long-term migration of residual contaminants, or short-term release of residual waste contents due to catastrophic failure. Stabilization may encompass filling the tank with grout and stabilizing wastes, or a simple gravel fill to prevent tank dome collapse. Barrier technology may include engineered surface barriers to prevent water, plant, and animal intrusion, or subsurface barriers that prevent contaminants or moisture from migrating downward to the water table.

Funding History



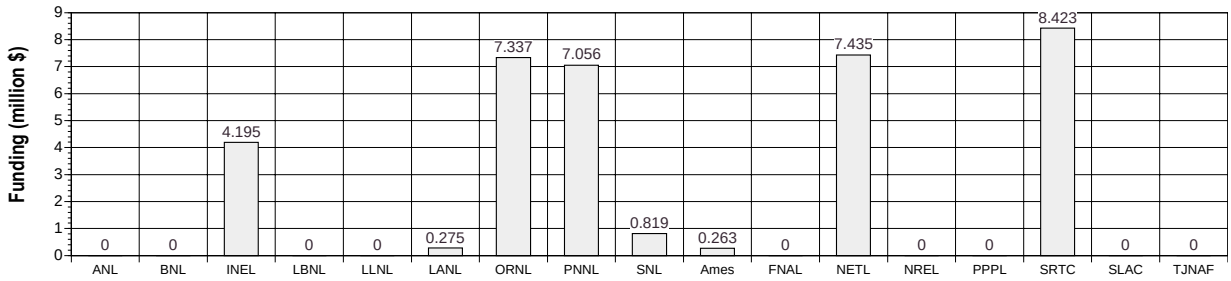
Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Notes: The Funding History chart shows total funding for all TD&D program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page. NETL provides contract management as technical support.

Environmental Quality | **Strategic Goal: Management of Waste/Materials**

Program Area: Management of High-Level Waste

R&D Activity: Directed Science

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Basic and Applied Research

DOE Laboratory Performers

Principal Laboratories: PNNL
Contributing Laboratories: LANL, ORNL
Participating Laboratories: ANL, BNL, INEEL, LBNL, SNL, SRTC

Strategic Goals and Objectives

- Solve environmental problems associated with the wastes in the underground storage tanks.
  - Storage
  - Processing
  - Disposal

R&D Activities

Actinide Chemistry (B&R code: EW.40.90.10.0)
- Determine chemical behavior, solubility, and speciation of uranium, neptunium, plutonium, and americium in simulated tank waste sludges and scrubber liquor.

Analytical Chemistry (B&R code: EW.40.90.10.0)
- Projects focus on laser ablation techniques, mass spectrometry, and sensors, as applied to chemical and physical characterization of high level wastes in tanks and during processing.

Engineering Science (B&R code: EW.40.90.10.0)
- Develop engineering fundamentals to address waste treatment and tank safety issues.

Geochemistry (B&R code: EW.40.90.10.0)
- Provide sorption and desorption research relative to HLW treatment and remediation, retrieval, and separation processes.

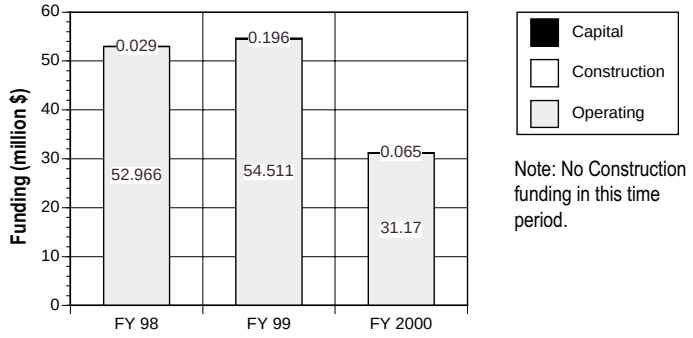
Hydrology (B&R code: EW.40.90.10.0)
- Investigate the causes and extent of nonuniform flow in the vadose zone and its effects on the migration of contaminants leaked from single-shell tanks at Hanford.

Inorganic Chemistry (B&R code: EW.40.90.10.0)
- Study and understand the complex chemistry of wastes including non radioactive components and specific radionuclides such as technetium in waste storage, washing, and transfer.

Materials Science (B&R code: EW.40.90.10.0)
- Focus directed research on chemical and structural properties of storage materials, radiation effects on storage materials, surface chemistry, and waste materials.

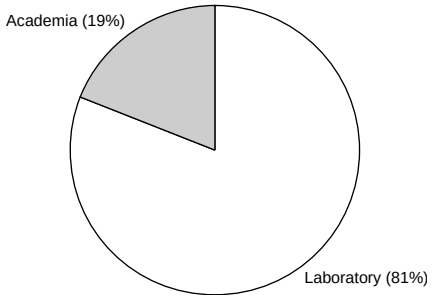
Separations Chemistry (B&R code: EW.40.90.10.0)
- Conduct basic research to create materials with large ion exchange capacity and selectivity for cesium.

Funding History



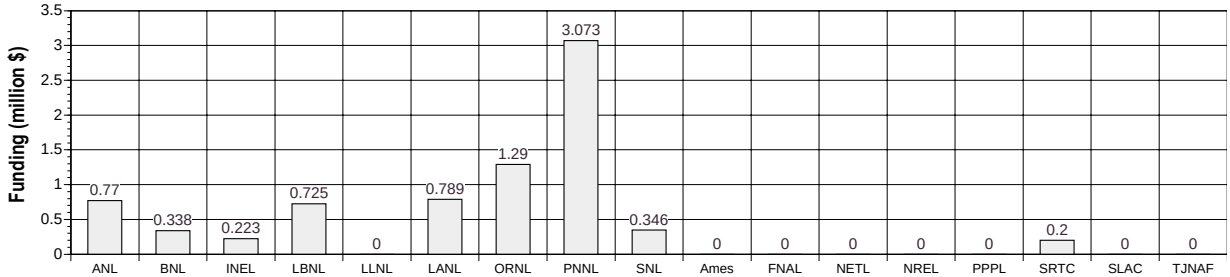
Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Notes: The Funding History chart shows total funding for all Directed Science program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page. NETL provides contract management as technical support.

Environmental Quality | **Strategic Goal: Management of Waste/Materials**

Program Area: Management of Mixed Low-Level/TRU Waste

R&D Activity: Technology Development and Demonstration

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Technology Development and Demonstration

DOE Laboratory Performers

Principal Laboratories: INEEL
Contributing Laboratories: NETL
Participating Laboratories: Ames, ANL, LANL, ORNL, PNNL, SRTC

Strategic Goals and Objectives

- Develop very limited treatment options and disposal capacities for mixed and low-level/transuranic (MLLW/TRU) wastes.

R&D Activities

Waste Characterizaion (B&R code: EW.40.10.00.0)
- Improve end-users' capability to nondestructively examine and assay containerized waste for radioactive and hazardous components.

Transuranic Waste Transportation (B&R code: EW.40.10.00.0)[1]
- Increase the container payload efficiency of transuranic waste shipments for treatment and disposal. DOE, working in conjunction with the Carlsbad Area Office, has developed a strategy (the TRUPACT-II Payload Expansion Plan, Westinghouse Waste Isolation Division) to address the flammable gas impact on transuranic waste transportation.

Waste Handling (B&R code: EW.40.10.00.0)
- Enable end-users to remotely handle highly radioactive waste streams for sizing, repackaging, and transport.

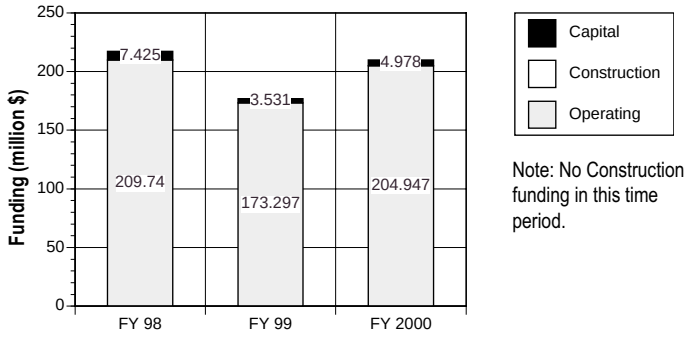
Alternatives to Incineration (B&R code: EW.40.10.00.0)
- Provide nonflame alternatives (which can be thermal or nonthermal) to incineration for organic waste destruction. The strategy to resolve these problems involve two areas: solution development and solution deployments.

Off-Gas Monitoring and Filtration (B&R code: EW.40.10.00.0)
- Improve off-gas monitoring and environmental performance of the DOE's waste incinerators to meet new regulatory requirements. The strategy to resolve the problems associated with monitoring and controlling emissions is based upon logical groupings of problems: emission monitoring and emission control.

Mercury Contamination (B&R code: EW.40.10.00.0)
- Improve end-users' efficiency in managing mercury as a mixed waste contaminant. The strategy to resolve the problems associated with mercury waste streams is based upon several problem areas: mercury amalgamation, mercury stabilization, and mercury separation and removal.

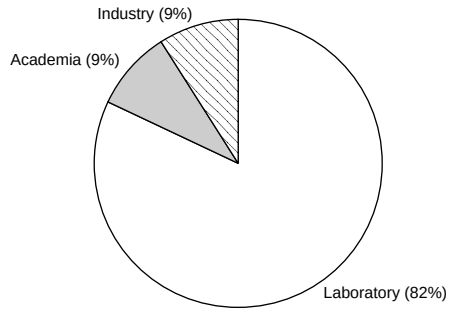
Unique Wastes (B&R code: EW.40.10.00.0)
- Provide specialized solutions for small-quantity, problematic mixed waste streams. The strategy to resolve the problems associated with the small quantity, problematic waste streams is based upon the following problem areas: organic waste streams, high energetic waste streams, radioactive sources and problematic waste streams.

Funding History



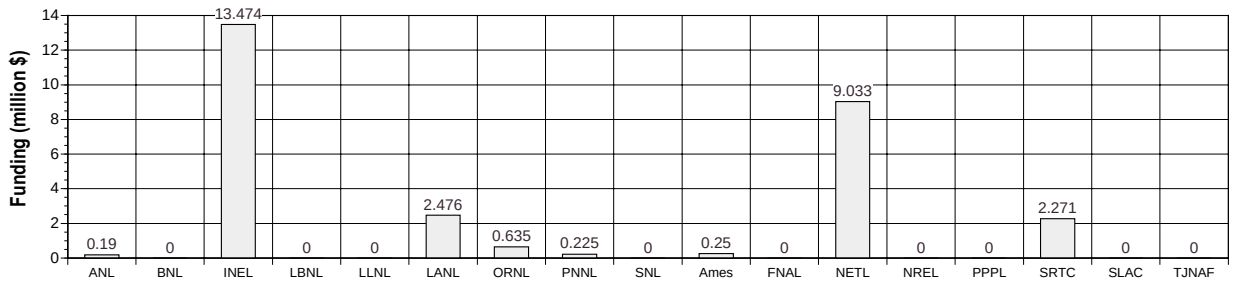
Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Notes: The Funding History chart shows total funding for all TD&D program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page.
NETL provides contract management as technical support.

Environmental Quality | **Strategic Goal: Management of Waste/Materials**

Program Area: Management of Mixed Low-Level/TRU Waste

R&D Activity: Directed Science

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Basic and Applied Research

DOE Laboratory Performers

Principal Laboratories: LANL, LBNL
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

- Solve environmental problems associated with very limited treatment options and disposal capacities for mixed low-level/transuranic (MLLW/TRU) wastes.

R&D Activities

Actinide Chemistry (B&R code: EW.40.90.10.0)
- Address synthesis of new materials for interface to applied separation technologies.

Analytical Chemistry and Instrumentation (B&R code: EW.40.90.10.0)
- Focus on mass spectrometry, sensors, and techniques for remote diagnosis of chemical species in hazardous gas, liquid, and semi-solid phases.

Engineering Science (B&R code: EW.40.90.10.0)
- Research bubble mechanics and sonification, and design, process, and modeling for the handling, characterization, and treatment of TRU and mixed low-level wastes.

Inorganic Chemistry (B&R code: EW.40.90.10.0)
- Focus is on hydrothermal oxidation, multiphase/gaseous chemistry, and solid/solution chemistry.

Materials Science (B&R code: EW.40.90.10.0)
- Focus on chemical and structural properties of storage materials, and surface chemistry.

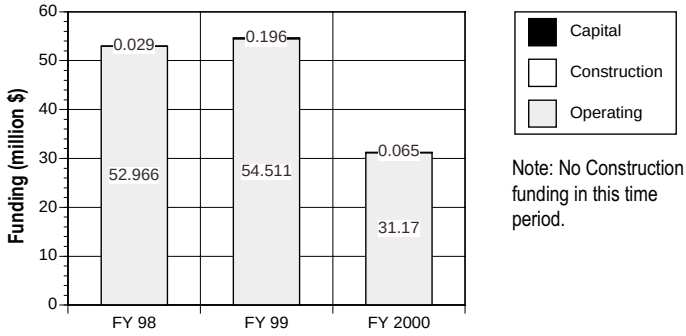
Separations Chemistry (B&R code: EW.40.90.10.0)
- Conduct research in catalyst chemistry and waste treatment, and ligand design and ion exchange.

Transport Aspects of Selective Mass Transport Agents (B&R code: EW.40.90.10.0)
- Study selective mass transport in polymers, pore size and morphology control for solid and polymer matrices, and adsorption and absorption materials for molecular separations.

Characterization Science (B&R code: EW.40.90.10.0)
- Develop characterization methods including intelligent nonintrusive methods, adaptive sensors, integrated sensors for in-situ chemical measurement, nondestructive assay, and nuclear structure.

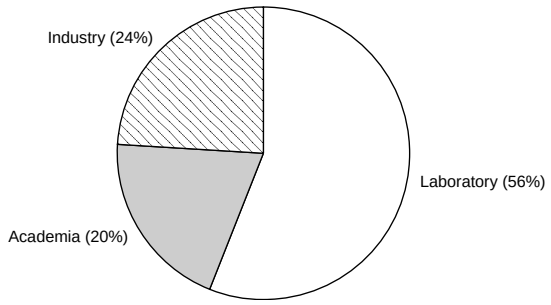
Computational Simulation of Mechanical and Chemical Systems (B&R code: EW.40.90.10.0)
- Deliver computational modeling capability and results for chemical and physical processes that occur in the wide range of systems of importance to DOE EM including computational infrastructure and computational simulation.

Funding History



Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



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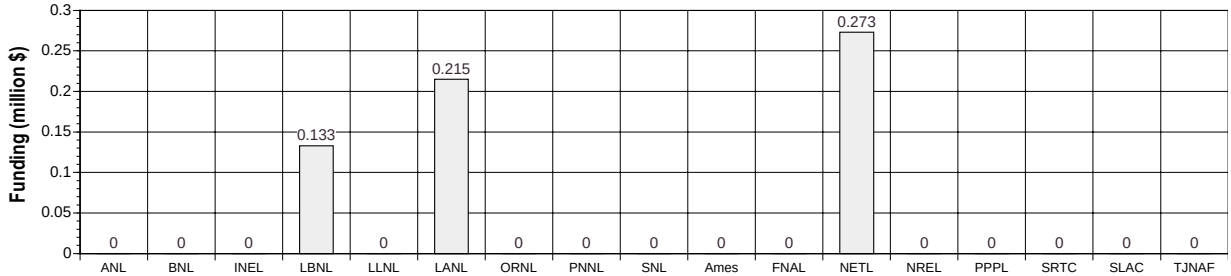


Notes: The Funding History chart shows total funding for all Directed Science program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page. NETL provides contract management as technical support.

Environmental Quality | **Strategic Goal: Management of Waste/Materials**

Program Area: Management of Spent Nuclear Fuel

R&D Activity: Technology Development and Demonstration

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Technology Development and Demonstration

DOE Laboratory Performers

Principal Laboratories: INEEL, SRTC
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

- Solve environmental problems associated with safely and efficiently managing spent nuclear fuel
  - Domestic reactors
  - Foreign reactors

R&D Activities

Data Acquisition and Validation (B&R code: EW.40.10.00.0)

- Data specific to each of over 200 types of DOE SNF is needed prior to certification of the fuel for the mined geological repository (MGR). The available data may not meet the recent improved and more stringent standards. Investments are needed in two areas: one, to determine the necessary pedigree required to "qualify" existing fuel data, and two, in systems for qualifying all data related to DOE SNF types including assembling original manufacturer data & drawings, reactor history, post irradiation examinations, fissile loading, burnups, storage since reactor withdrawal, fuel quantities, fuel matrix, etc.

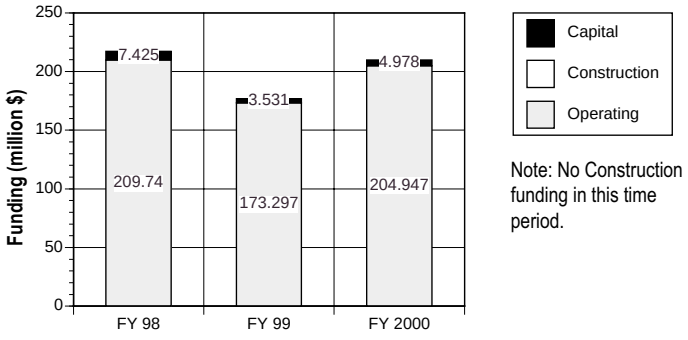
Treatment or Conditioning (B&R code: EW.40.10.00.0)

- In some cases the spent fuel may require conditioning or treatment to prepare it for disposal or long term storage. Investments are needed to complete the development and validation of processes for conditioning/treating specific fuel types, e.g., Na bonded, small lot scrap, disrupted fuel, and melt dilute for aluminum clad SNF.

Packaging for Dry Storage (B&R code: EW.40.10.00.0)

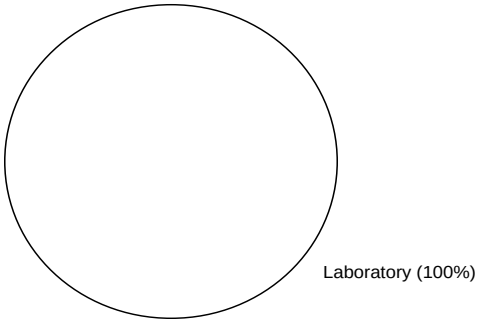
- Extended, interim, dry storage of SNF is the preferred path for safe management of DOE SNF until shipment to the MGR. At present, most SNF is or has been stored in water basins. In some of these basins, measurable corrosion of the SNF has occurred. Movement of all SNF into dry storage will limit or eliminate potential corrosion mechanisms. For some SNF, repackaging will be needed to ensure containment during the extended storage period. Investments are needed into packaging requirements, which will assure safe dry storage for periods up to 40 years. Packaging must maintain adequate SNF integrity, prevent undue corrosion, and be able to be adequately monitored throughout the dry storage period. It also would ensure that at the end of the extended interim storage the SNF and canister would meet the MGR Disposability Interface Specifications. Focus also is on activities related to retired basin storage facilities.

Funding History



Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



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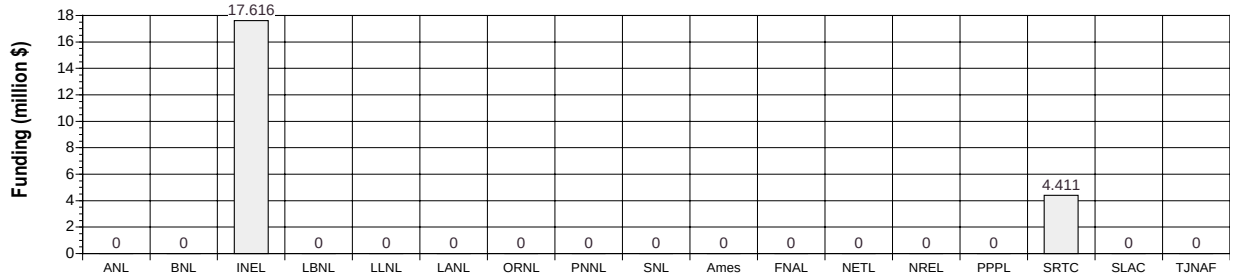


Notes: The Funding History chart shows total funding for all TD&D program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page.
NETL provides contract management as technical support.

Environmental Quality | **Strategic Goal: Management of Waste/Materials**

Program Area: Management of Spent Nuclear Fuel

R&D Activity: Directed Science

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Basic and Applied Research

DOE Laboratory Performers

Principal Laboratories: PNNL, BNL
Contributing Laboratories: ANL
Participating Laboratories: None

Strategic Goals and Objectives

- Solve environmental problems associated with safely and efficiently managing spent nuclear fuel.
  - Domestic reactors
  - Foreign reactors

R&D Activities

Analytical Chemistry and Instrumentation (B&R code: EW.40.90.10.0)
- Develop detectors for direct imaging of spent nuclear fuels and fissile materials.

Engineering Science (B&R code: EW.40.90.10.0)
- Develop techniques to model fluid flow in spent nuclear fuel canisters.

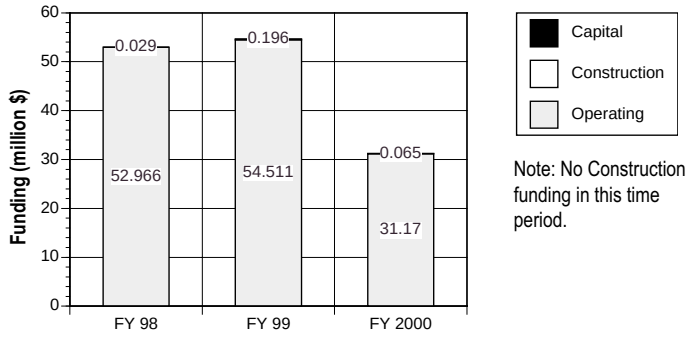
Geochemistry (B&R code: EW.40.90.10.0)
- Perform long-term assessment of radionuclide immobilization in the phases formed by corrosion of spent nuclear fuel and immobilization of radionuclides in the alteration phases of spent fuel.

Separations Chemistry (B&R code: EW.40.90.10.0)
- Conduct specific research in the area of catalyst chemistry and waste treatment.

Materials Dynamics (B&R code: EW.40.90.10.0)
- Conduct studies in the following major areas: 1) Transport in solid and liquid media, 2) Corrosion and aging, 3) Coatings for environmental applications.

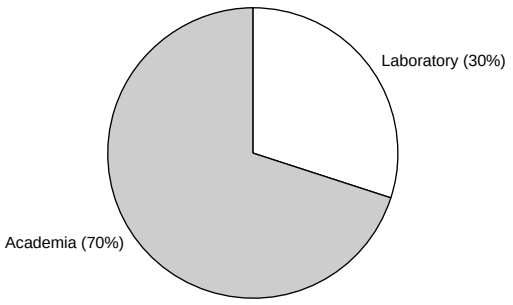
Computational Simulation of Mechanical and Chemical Systems (B&R code: EW.40.90.10.0)
- Perform computations to support the understanding of fracture propagation in materials and interfacial properties of coatings and their substrates that relate to coating performance are being studied.

Funding History



Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



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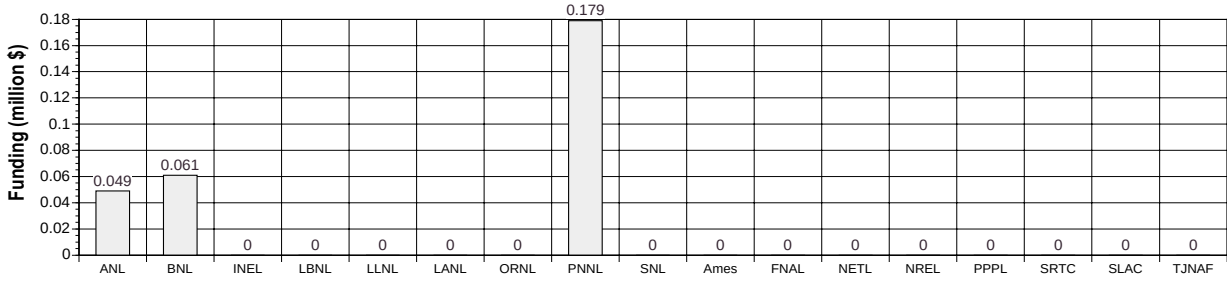


Notes: The Funding History chart shows total funding for all Directed Science program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page. NETL provides contract management as technical support.

Environmental Quality | **Strategic Goal: Management of Waste Material**

Program Area: Management of Nuclear Materials

R&D Activity: Performance Testing and Qualification for Repository Disposal

DOE Programs

Program: Office of Fissile Materials Disposition
Office: Office of Materials and Immobilization

DOE Laboratory Performers

Principal Laboratories: LLNL, ANL, PNNL
Contributing Laboratories: None
Participating Laboratories: None

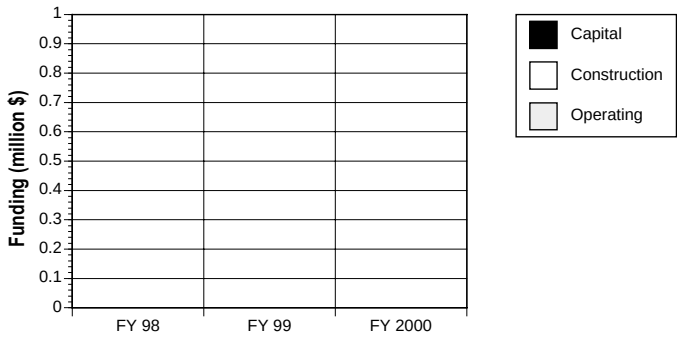
Strategic Goals and Objectives

- Dispose of surplus weapons-usable plutonium by transforming the material into forms not readily accessible for use in nuclear weapons (mixed-oxide spent fuel and an immobilized plutonium).
  – The Performance testing effort is designed to support analyses for the Repository License Application.
  – The Form Qualification effort is to to demonstrate that the plutonium forms meet deep geologic disposal requirements.
  LLNL: Provide thermochemical and physical property data and a long-term dissolution model of the ceramic form.
  ANL: Conduct both short-term and long-term tests to study the dynamic behavior of the ceramic material.
  PNNL: Examine the effects of radiation damage on the physical and chemical properties of the ceramic form and provide thermochemical data on various complex chemical systems.

R&D Activities

– Short-term and long-term dissolution tests designed to characterize the degradation behavior of the high-performance ceramic forms.
– Obtain thermochemical data of different phases comprising the ceramic formulation and other complex chemical systems.
– Develop acceptance specifications for the plutonium product and demonstrate compliance through tests.
– Develop Product Control Model.

Funding History



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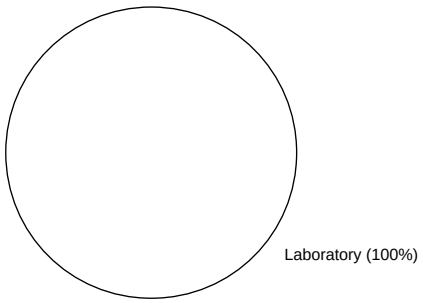

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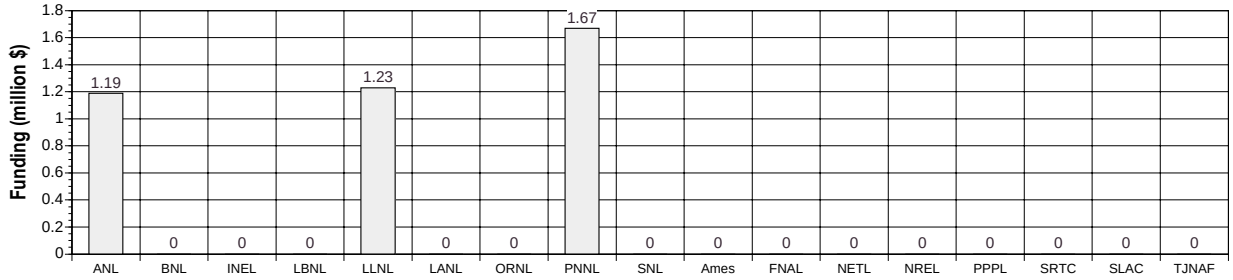


Environmental Quality | **Strategic Goal: Management of Waste/Materials**

Program Area: Management of Nuclear Materials

R&D Activity: Technology Development and Demonstration

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Technology Development and Demonstration

DOE Laboratory Performers

Principal Laboratories: LANL
Contributing Laboratories: None
Participating Laboratories: INEEL, NETL, PNNL, SNL

Strategic Goals and Objectives

- Solve environmental problems associated with unstable materials and their long term storage
  - Plutonium and oxides
  - Highly enriched Uranium
  - Nuclides of other Actinide elements

R&D Activities

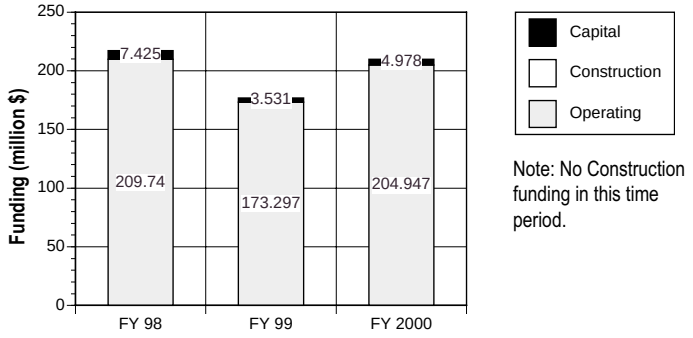
Performance Qualification and Testing (B&R code: EW.40.10.00.0)
- A series of short-term (a few days) and long-term (years) tests designed to characterize the degradation behavior of the high-performance ceramic forms are being conducted. Effects of radiation damage due to alpha decay of plutonium are also being studied. A number of other tests are also being conducted to obtain thermochemical data of different phases comprising the ceramic formulation, and other complex chemical systems, including gadolinium, hafnium, uranium phosphates, plutonium phosphates, and titanium oxide.

Stabilization (B&R code: EW.40.10.00.0)
- Salt Stabilization Technologies - Develop technologies to stabilize the over 18 metric tons of pyrochemical salt residue in storage within the DOE weapons complex, which is considered unacceptable for safe interim storage, as specified in DNFSB Recommendation 94-1. [1]
- U-233 Stabilization Technologies - U-233 fissile material was not included in the HEU or Pu EIS, but the process of developing a national policy to address such issues as nonproliferation, safeguards and security, environmental and nuclear safety, is underway via the 97-1 Implementation Plan and the NMI program.

Packaging, Transportation, and Storage (B&R code: EW.40.10.00.0)
- Integrated Monitoring and Surveillance System - The Integrated Monitoring and Surveillance System (IMSS) project provides a complex-wide resource for process definitive testing of sensor, measurement, and process integration technologies necessary for the monitoring and surveillance of SNM contained in short, intermediate, and long-term storage configurations.
- Recycled Metal Container Technologies - Radioactive Scrap Metal (RSM) is a major waste stream within the DOE and is primarily classified as LLW awaiting disposal. Scrap metal recycling is routine and economically significant within private industry.

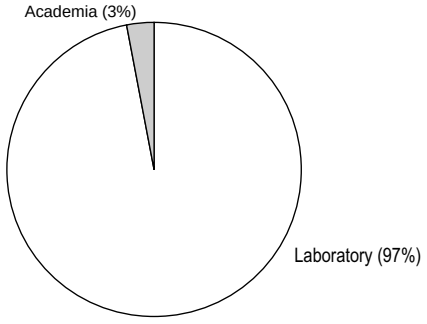
Site Technology Support (B&R code: EW.40.10.00.0)
- A major element of this area is likely to be supporting implementation of stabilization approaches and support for de-inventory initiatives.

Funding History



Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



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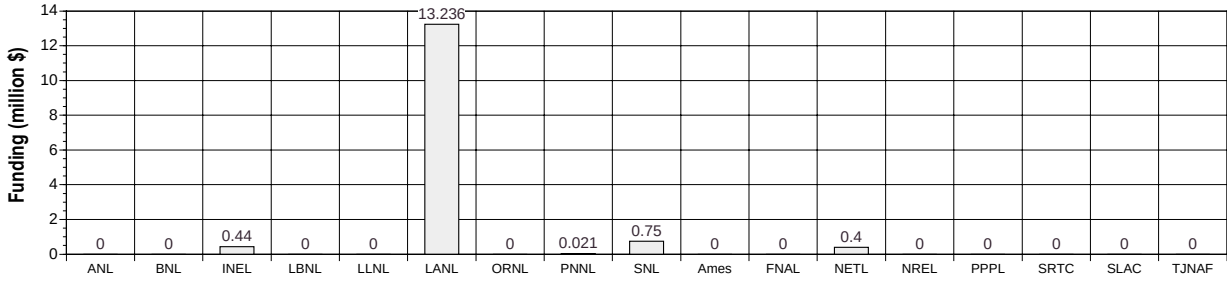


Notes: The Funding History chart shows total funding for all TD&D program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page.
NETL provides contract management as technical support.

Environmental Quality | **Strategic Goal: Management of Waste/Materials**

Program Area: Management of Nuclear Materials

R&D Activity: Directed Science

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Basic and Applied Research

DOE Laboratory Performers

Principal Laboratories: LLNL, PNNL
Contributing Laboratories: ANL, LANL, ORNL
Participating Laboratories: LBNL

Strategic Goals and Objectives

- Solve environmental problems associated with unstable materials and their long-term storage.
  - Plutonium and oxides
  - Highly enriched uranium
  - Nuclides of other actinide elements

R&D Activities

Actinide Chemistry (B&R code: EW.40.90.10.0)

- Develop basic scientific (thermodynamic) understanding of actinide volatilization and partitioning/ speciation behavior in the thermal processes that are central to DOE/EM mixed waste treatment program.

Analytical Chemistry and Instrumentation (B&R code: EW.40.90.10.0)

- Develop a new analytical instrument based on the principle of nuclear magnetic resonance for in-situ, in-field and in-process characterization and monitoring of various substances and chemical processes.

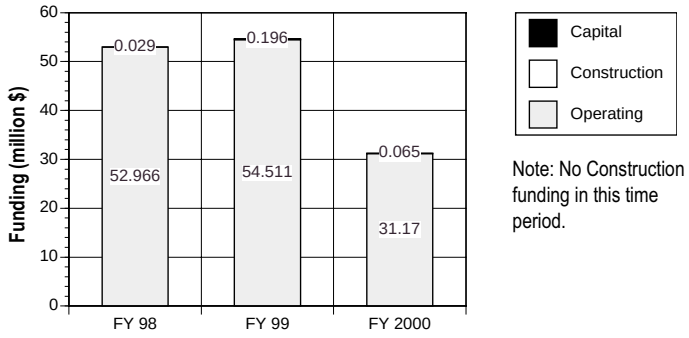
Engineering Science (B&R code: EW.40.90.10.0)

- Utilize novel computational techniques, improved nuclear data, and new analytical methods to address criticality safety issues.

Materials Science (B&R code: EW.40.90.10.0)

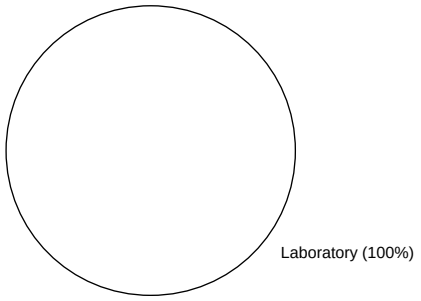
- Determine chemical and structural properties of storage materials, and radiation effects on storage materials. Ceramic waste forms such as monazite, pyrochlore, zircon, and zirconolite are being studied.

Funding History



Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



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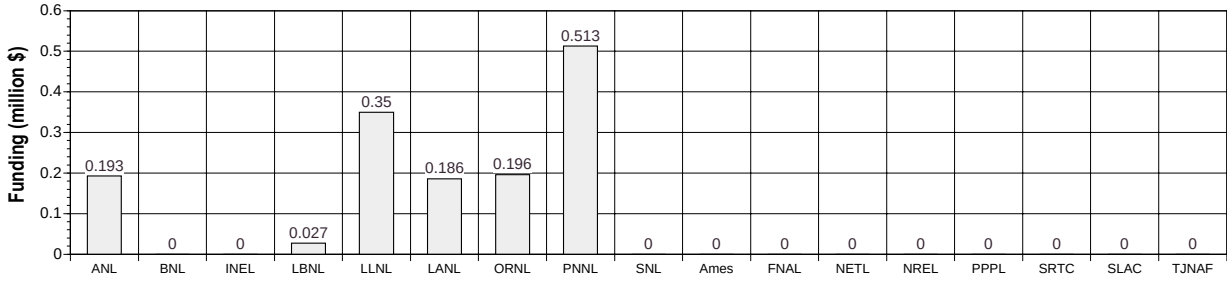


Notes: The Funding History chart shows total funding for all Directed Science program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page. NETL provides contract management as technical support.

R&D Activity: Yucca Mountain Site Characterization

DOE Programs

Program: Office of Civilian Radioactive Waste Management
Office: Civilian Radioactive Waste Management
Yucca Mountain Site Characterization

DOE Laboratory Performers

Principal Laboratories: LLNL
Contributing Laboratories: LANL, SNL
Participating Laboratories: ANL, LBNL, ORNL, PNNL

Strategic Goals and Objectives

- Complete the characterization of the Yucca Mountain site.
- Develop the final environmental impact statement for the Yucca Mountain site.
- Prepare and submit site recommendation to the President.
- Develop and submit a license application to the Nuclear Regulatory Commission for construction authorization, if the site is designated.

R&D Activities

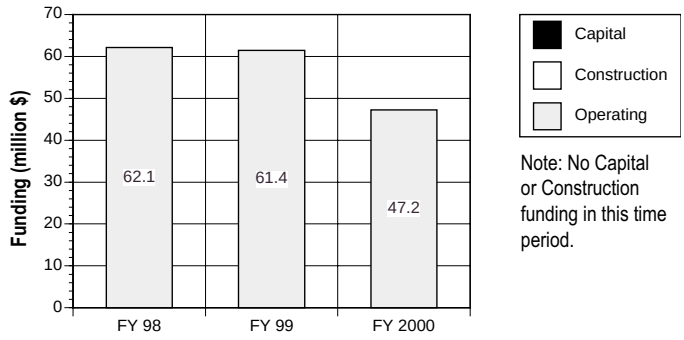
Core Science (DF01): Studies how the natural environment within the immediate vicinity, or near-field, of the waste packages will be affected by excavation of the waste emplacement drifts and othre underground openings, by the heat generated by the waste, or by the introduction of nonnative materials.

Design and Engineering (DF01): Effort includes evaluating waste container materials (to include structural inserts and engineered criticality controls) that can withstand the range of conditions in the repository to prevent significant corrosion over the long time frames needed to ensure adequate waste containment and isolation.

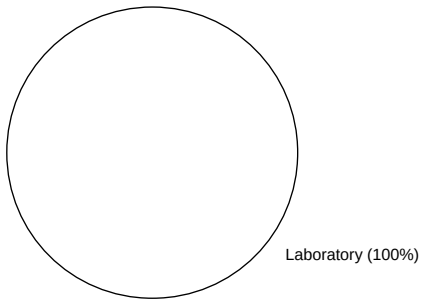
Total System Performance Assessment (DF01): Process models to assess the future performance of the repository, are mathematical representations of features, events, and processes that could affect how the repository could function. Taken together, the abstraction of the process models comprise the Total System Performance Assessment model used to evaluate future doses of radiation to persons living near Yucca Mountain for thousands of years into the future.

R&D Support (DF01): Includes maintenance of technical databases, sample management, quality control of project activities, external peer reviews of products, activities associated with project management, and ensures that all R&D efforts are integrated among the various project participants.

Funding History



Laboratory-Academia-Industry Participation



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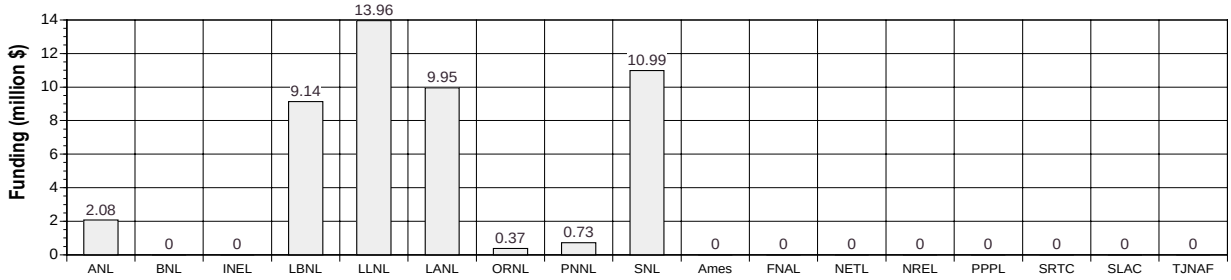


Environmental Quality | **Strategic Goal: Enhance Future Land Use**

Program Area: Environmental Remediation

R&D Activity: Technology Development and Demonstration

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Technology Development and Demonstration

Laboratory Complex

Principal Laboratories: INEEL
Contributing Laboratories: NETL, SRTC
Participating Laboratories: Ames, ANL, BNL, LANL, LBNL, LLNL, ORNL, PNNL, SNL

Strategic Goals and Objectives

- Remediate the contaminated environment to levels acceptable for long term monitoring or reuse depending on land use policy decisions.

R&D Activities

Identify (B&R code: EW.40.10.00.0)
- Vadose and Saturated Zone Characterization, Monitoring, Modeling, and Analysis - Fill the significant technology gaps that limit our ability to understand the inventory, distribution and movement of contaminants in the vadose and saturated zones.

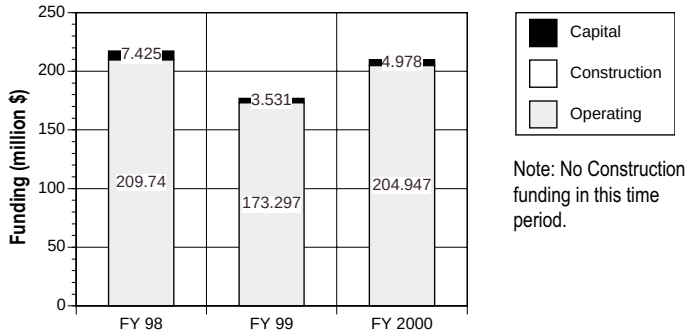
Contain (B&R code: EW.40.10.00.0)
- Subsurface Barrier Systems in the Vadose Zone - Provide for the effective containment of leaking landfills, trenches, tanks, and high-concentration plumes.
- Stabilization of Contaminants in the Vadose Zone - Effective stabilize unstable buried wastes which continue to leach and contribute to increased risks and the growth of long-term liability.
- Long Lived Caps - Much of the waste at DOE sites should be isolated from the environment for hundreds of years. Long-term cover systems must be developed to provide robust waste isolation over a range of climatic conditions and extreme events.

Remediate (B&R code: EW.40.10.00.0)
- In Situ Passive Flow, Reactive Treatment Barriers - Effectively remediate dispersed-contaminant plumes.
- Advanced Bioremediation and Enhanced Natural Attenuation - Remediate low to moderate concentrations of organic solvents that are common in soil, ground water, and leaking buried waste at many DOE sites.
- Treatment of Vadose Zone Using Chemical Treatment - Provide effective methods to remediate metals, rads, explosive residues, DNAPLs, and solvents in the vadose zone.
- Chemical Treatment of the Saturated Zone - Replace traditional recovery-type remediation technologies that are too inefficient and time consuming.
- Deep Subsurface Access and Placement Methods - Provide the capability to provide access, sampling, and delivery methods to place characterization and treatment technologies in DOE's deep plumes.

Remove (B&R code: EW.40.10.00.0)
- Hot Spot Removal from Landfills and Subsurface Sources - Provide the capability to effectively characterize and remove highly radioactive, explosive, and pyrophoric wastes which pose an unacceptable risks to remediation workers during excavation.

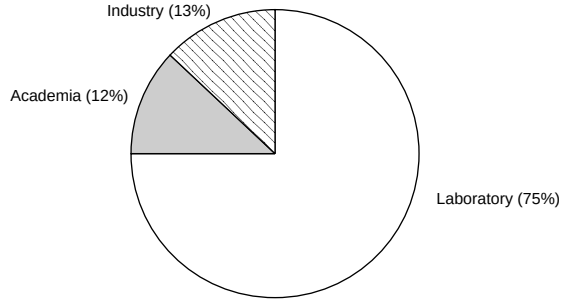
Validate (B&R code: EW.40.10.00.0)
- In Situ Passive Flow, Reactive Treatment Barriers - Provide methods to validate the integrity of containment systems, predict long-term performance to meet stakeholder and regulatory concerns, and thereby enable their use as a remedy.

Funding History



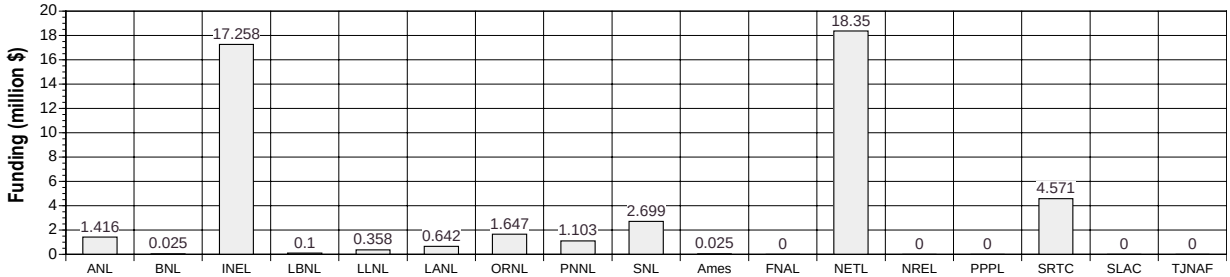
Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Notes: The Funding History chart shows total funding for all TD&D program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page.
NETL provides contract management as technical support.

Environmental Quality | **Strategic Goal: Management of Waste/Materials**

Program Area: Environmental Remediation

R&D Activity: Directed Science

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Basic and Applied Research

Laboratory Complex

Principal Laboratories: PNNL
Contributing Laboratories: LANL, ORNL
Participating Laboratories: BNL, INEEL, LBNL, LLNL, SNL, SRTC

Strategic Goals and Objectives

- Remediate the contaminated environment to levels acceptable for long-term monitoring or reuse depending on land use policy decisions.

R&D Activities

Actinide Chemistry (B&R code: EW.40.90.10.0)
- Focus is on providing a better understanding of the speciation, characterization, and migration of plutonium in soils and surface and ground waters.

Analytical Chemistry and Instrumentation (B&R code: EW.40.90.10.0)
- Develop protocols for quantitative analysis of tank waste materials based upon tunable infrared ultra pulsed lasers.

Biogeochemistry (B&R code: EW.40.90.10.0)
- Investigate reduction and immobilization properties of metals, radionuclides, and other contaminants in various media.

Engineering Science (B&R code: EW.40.90.10.0)
- Conduct research to investigate the in situ degradation of semi-volatile organic compounds to allow for more cost effective vapor stripping and biological treatment.

Geochemistry (B&R code: EW.40.90.10.0)
- Perform research including studies in colloidal chemistry and transport and sorption/desorption.

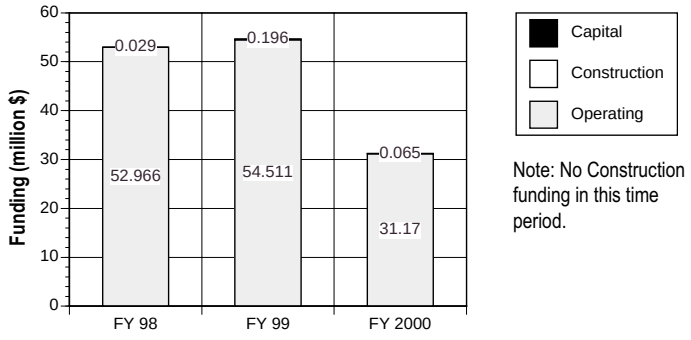
Geophysics (B&R code: EW.40.90.10.0)
- Focus on developing methods for subsurface imaging.

Health Science (B&R code: EW.40.90.10.0)
- Perform research focused on molecular, structural, and genomic science.

Hydrogeology (B&R code: EW.40.90.10.0)
- Focus research on dense non aqueous phase liquid (DNAPL) dynamics, fluid-flow, colloidal dynamics, and instrumentation and modeling.

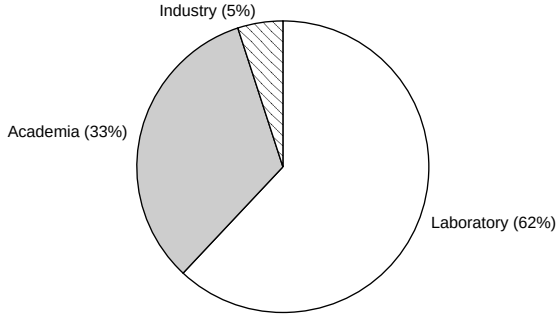
Microbial Science (B&R code: EW.40.90.10.0)
- Projects include identifying attachment/detachment dynamics of anaerobic bacteria, conditions by which they partition between aqueous and solid phases, and the stress inducible gene from two soil bacteria.

Funding History



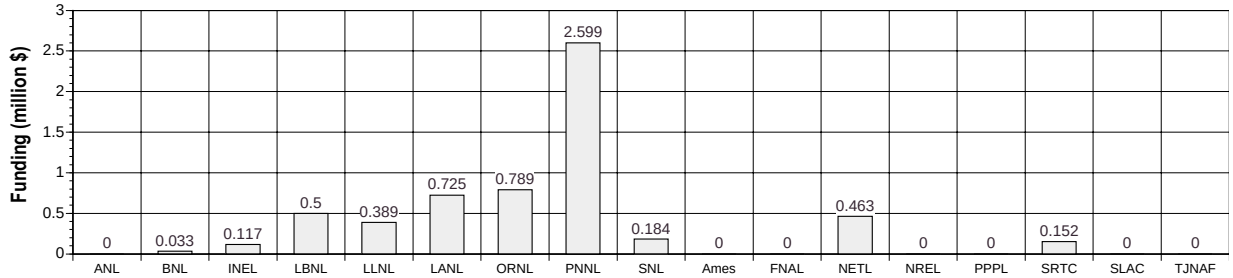
Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Notes: The Funding History chart shows total funding for all Directed Science program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page. NETL provides contract management as technical support.

Environmental Quality | **Strategic Goal: Enhance Future Land Use**

Program Area: Deactivation and Decommissioning

R&D Activity: Technology Development and Demonstration

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Technology Development and Demonstration

DOE Laboratory Performers

Principal Laboratories: INEEL, NETL
Contributing Laboratories: BNL
Participating Laboratories: ORNL, PNNL, SRTC

Strategic Goals and Objectives

- To place equipment and structures from surplus facilities in a desired end state
  - Deactivate
  - Decontaminate
  - Decommission

R&D Activities

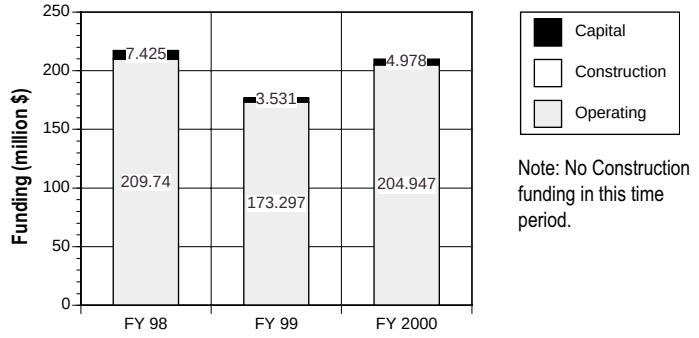
Reactor Facilities (B&R code: EW.40.10.00.0)
- There are 14 surplus production reactors across the DOE weapons complex, which represent a significant portion of the long-term D&D mortgage. There are also over 100 test and research reactors throughout DOE and U.S. universities, as well as many commercial nuclear reactors that are approaching their life expectancy will require D&D. Improved technologies for characterization, decontamination and dismantlement that will lower overall cost to D&D these aging facilities as well as lower risks to workers involved in D&D operations. These improved/innovative technologies will be demonstrated and deployed to help facilitate interim safe storage of DOE's production reactors to help reduce long term surveillance and maintenance costs. Improved technologies in the areas of debris/sludge removal from fuel storage pools, fuel storage pool water treatment, and decontamination of the storage pool surface will also be demonstrated.

Radionuclide Separation Facilities (B&R code: EW.40.10.00.0)
- Improved, innovative technologies are required to deactivate and decommission radionuclide separation facilities, including gaseous diffusion plants, fuel reprocessing canyons, chemical separation facilities, uranium recycling facilities, lithium enrichment facilities, and heavy water production facilities. D&D activities also lead to potential valuable resources, such as scrap metal and concrete. At present, most of these materials are disposed of as waste since no technologies exist to characterize and/or decontaminate them for free release cost-effectively. Decontamination of concrete and metals for recycle or free release, will result in substantial life cycle cost savings.

Fuel and Weapons Component Fabrication Facilities (B&R code: EW.40.10.00.0)
- Improved and innovative technologies are required to deactivate and decommission fuel and weapons component fabrication facilities including uranium milling and refining facilities, fuel and target fabrication facilities, weapons component fabrication facilities and weapons disassembly, dismantlement, modification and maintenance facilities.

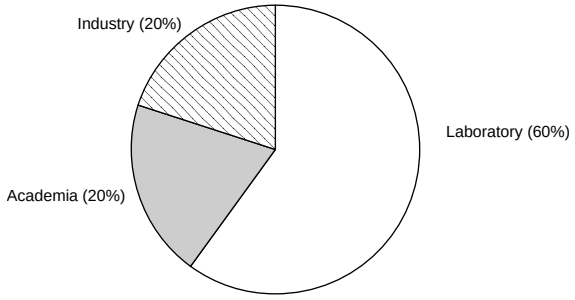
Laboratory Facilities (B&R code: EW.40.10.00.0)
- Laboratory facilities will address basic research, applied research, demonstrations and deployments of technologies and techniques for the D&D of laboratory facilities including hot cells and gloveboxes. D&D of these facilities, typically contaminated with high levels of radioactivity, will require remote/robotic applications to reduce worker exposure risk. The R&D is to develop remote/robotic systems that can operate in the confined working space often found in these facilities.

Funding History



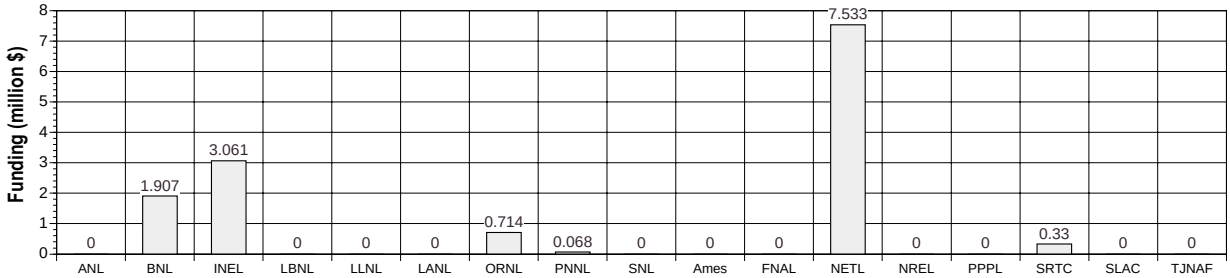
Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Notes: The Funding History chart shows total funding for all TD&D program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page.
NETL provides contract management as technical support.

Environmental Quality | **Strategic Goal: Enhance Future Land Use**

Program Area: Deactivation and Decommissioning

R&D Activity: Directed Science

DOE Programs

Program: Office of Environmental Management
Office: Office of Science and Technology
Office of Basic and Applied Research

DOE Laboratory Performers

Principal Laboratories: ORNL, PNNL
Contributing Laboratories: ANL, LANL, SNL
Participating Laboratories: BNL, LBNL, SRTC

Strategic Goals and Objectives

- Place equipment and structures from surplus facilities in a desired end state.
  - Deactivate
  - Decontaminate
  - Decommission

R&D Activities

Analytical Chemistry and Instrumentation (B&R code: EW.40.90.10.0)
- Develop nondestructive methods for identifying the hazardous asbestos in real time in the field using gamma spectroscopy. Develop simple new chemical sensing materials which can be utilized in chemical test strips to detect hazardous environmental pollutants.

Biochemistry(B&R code: EW.40.90.10.0)
- Develop improved methods for removing surface contamination.

Engineering Science (B&R code: EW.40.90.10.0)
- Focus is on robotics development and associated monitoring devices e.g. position sensitive germanium detectors.

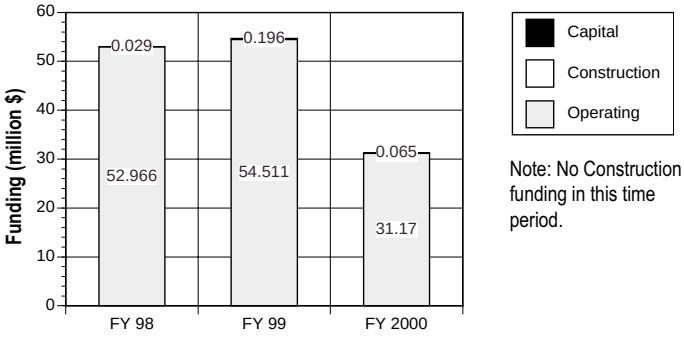
Inorganic Chemistry (B&R code: EW.40.90.10.0)
- R&D in this area centers on solid/solution chemistry. Studies include a robust process, Polymer Filtration which can address various conditions presented by dilute waste streams.

Materials Science (B&R code: EW.40.90.10.0)
- Focus is on surface chemistry and waste materials. Projects include study of atmospheric-pressure plasma jet, effects of heat on various contaminated structural materials, selectively removing radionuclides using hydroxycarboxylic acids, etc.

Separations Chemistry (B&R code: EW.40.90.10.0)
- Focus is on ligand design and ion exchange.

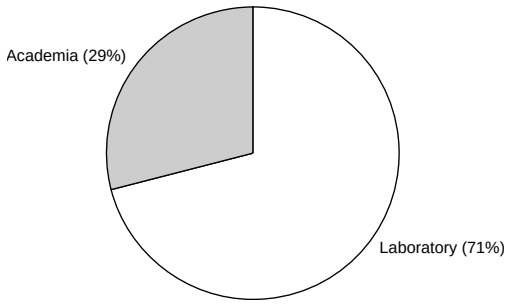
Robotics and Intelligent Machines (B&R code: EW.40.90.10.0)
- R&D target areas include advanced remote handling, advanced waste and tank environment characterization, remote work system mobility, task driven computer-aided engineering, remote operator-machine interface/cooperation, and remote operations simulation and training.

Funding History



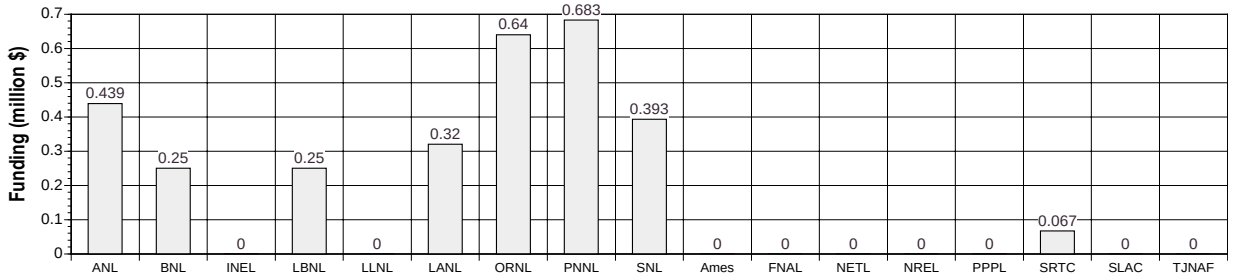
Note: No Construction funding in this time period.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



Notes: The Funding History chart shows total funding for all Directed Science program areas. The Laboratory-Academia-Industry Participation and Fiscal Year 2000 Funding Profile charts show funding only for the R&D activity described on this page. NETL provides contract management as technical support.

National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Directed Stockpile Work

R&D Activity: Stockpile Maintenance

DOE Programs

Program: Defense Programs
Office: Nuclear Weapons Stockpile

DOE Laboratory Performers

Principal Laboratories: SNL
Contributing Laboratories: LANL
Participating Laboratories: LLNL

Strategic Goals and Objectives

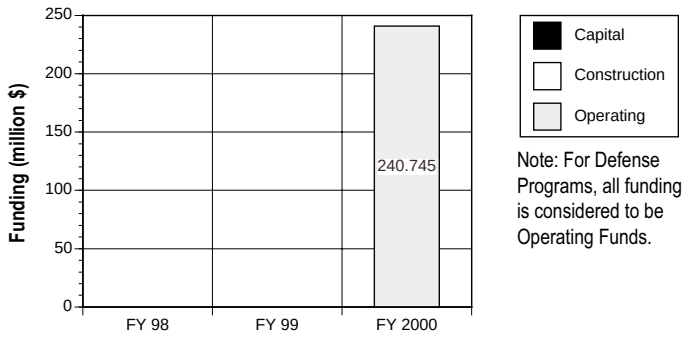
Stockpile Maintenance includes limited life component exchange, maintenance, and life extension activities on various weapon types in the enduring stockpile to maintain a safe and reliable weapons stockpile. Its goal is to ensure the operational safety, security, and reliability of the U.S. nuclear deterrent.

Development Activities

B&R: DP01

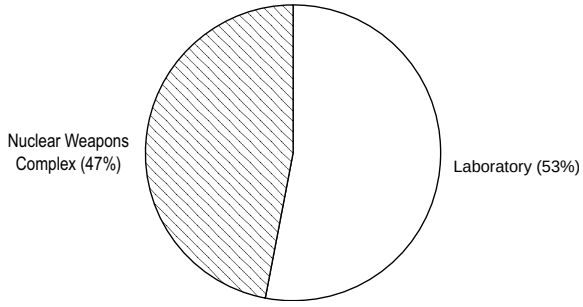
- Support Production and Planning Directive schedule for limited-life component exchange, consistent with START I and/or the ability to reactivate to START I.
- Support life-extension operations and repairs in accordance with Production and Planning Directive schedule for the B61 and B83-1 bombs.
- Support life-extension operations and repairs in accordance with Production and Planning Directive schedule for the W87 Life Extension Program.
- Development and Engineering, including material purchase support, program management, and quality support, tester/gauge maintenance and calibration, drafting, industrial engineering associated with stockpile refurbishment efforts.

Funding History



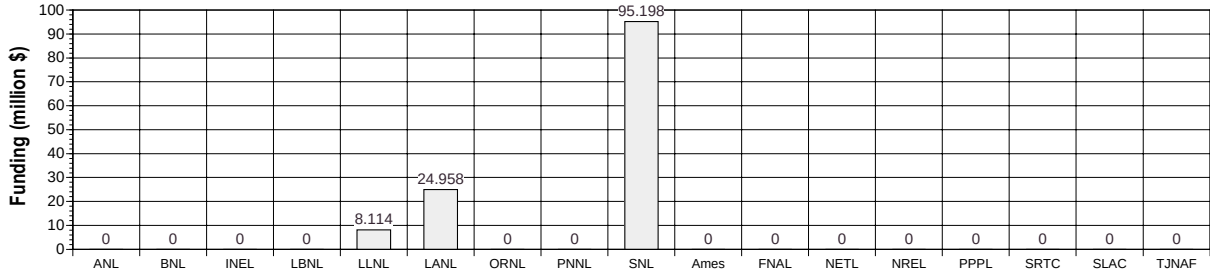
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



R&D Activity: Stockpile Evaluation

DOE Programs

Program: Defense Programs
Office: Nuclear Weapons Stockpile

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: LANL, SNL
Participating Laboratories: LLNL

Strategic Goals and Objectives

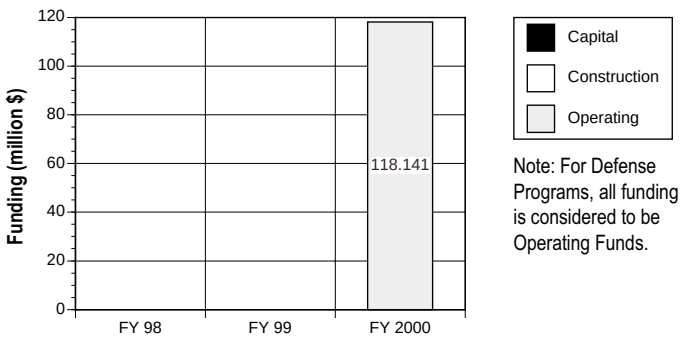
Stockpile Evaluation includes new materials laboratory tests, new materials flight tests, stockpile laboratory tests, stockpile flight tests, quality evaluations, special testing, and surveillance of weapon systems to assess the safety and reliability of the nuclear weapons stockpile as a basis for the Annual Certification to the President. Its goal is to ensure the operational safety, security, and reliability of the U.S. nuclear deterrent.

R&D Activities

B&R: DP0702

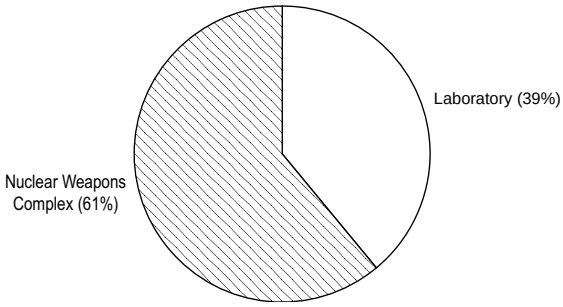
- Conduct new materials laboratory tests/stockpile laboratory tests to establish confidence in the performance, reliability, and safety of the nuclear weapon inventory.
- Conduct new materials flight tests/stockpile flight tests to establish confidence in the performance, reliability, and safety of the nuclear weapon inventory during its intended operational environment.
- Conduct surveillance testing to include special testing and surveillance of weapons systems to ensure quality evaluation and certification of the reliability of war reserve weapons and components.

Funding Histroy



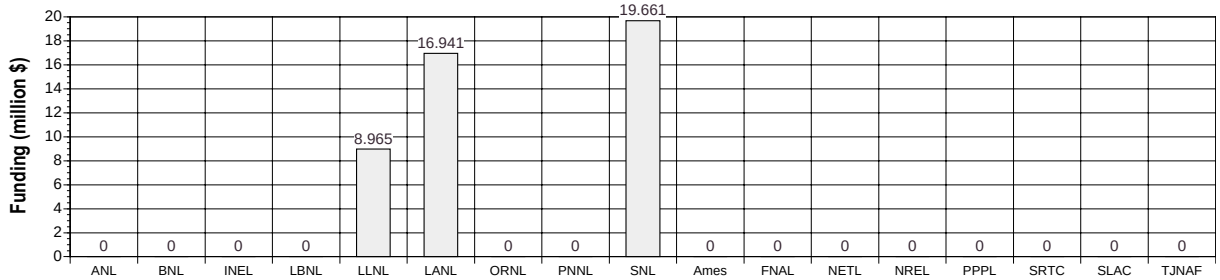
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Directed Stockpile Work

R&D Activity: Dismantlement/Disposal

DOE Programs

Program: Defense Programs
Office: Nuclear Weapons Stockpile

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: LANL, SNL
Participating Laboratories: LLNL

Strategic Goals and Objectives

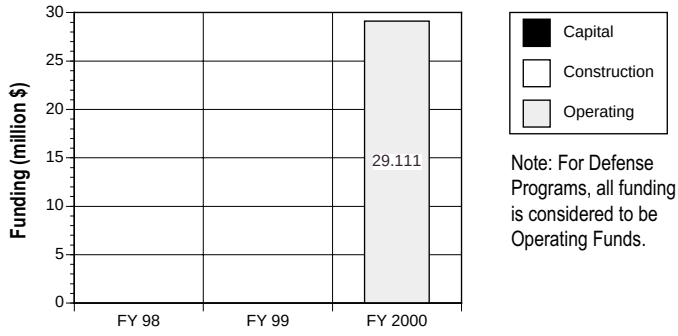
Dismantlement/Disposal includes all activities, including safety analysis, associated with weapon retirement, disassembly, component characterization, and disposal and reclamation of materials and components; the engineering, development, testing, certification, procurement, and refurbishment of containers required for interim storage; and the staging and storage of weapons, components, and materials awaiting dismantlement. Its goals are to ensure the safe dismantlement of nuclear weapons removed from the stockpile, and the reclamation or disposal of weapons parts resulting from dismantlement.

Development Activities

B&R: DP0703

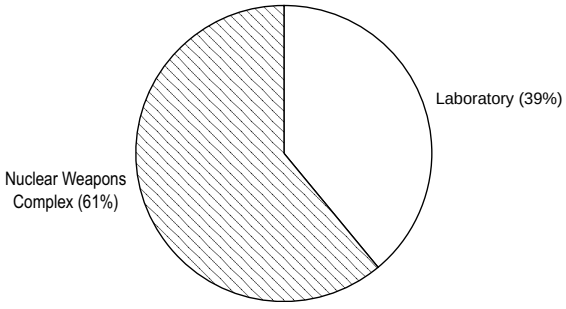
- Disassembly of retired weapons; characterization and disposition of components resulting from dismantlement; staging and storage of weapons, components or nuclear materials awaiting dismantlement.

Funding History



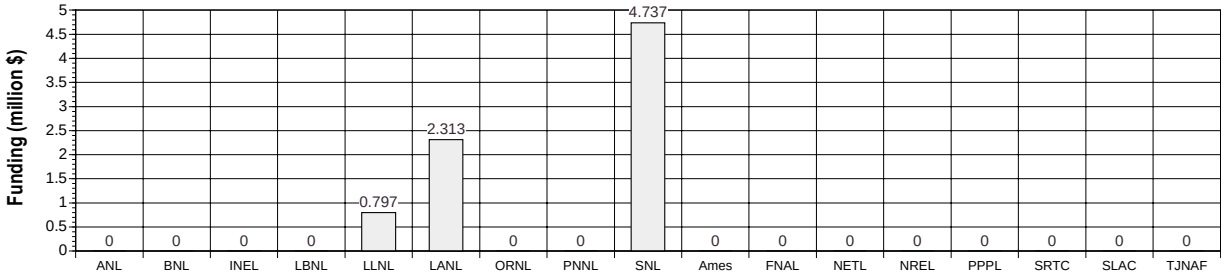
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Directed Stockpile Work

R&D Activity: Field Engineering, Training, and Manuals

DOE Programs

Program: Defense Programs
Office: Nuclear Weapons Stockpile

DOE Laboratory Performers

Principal Laboratories: SNL
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

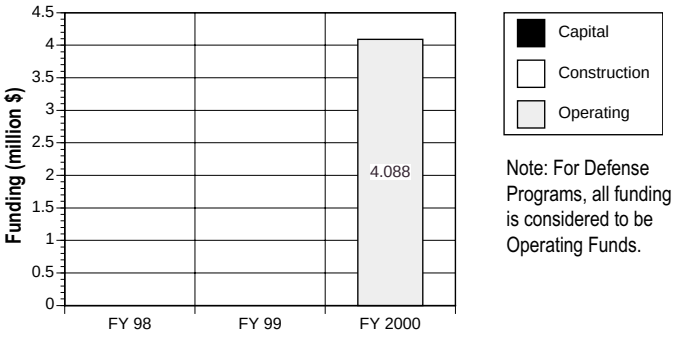
Field Engineering, Training and Manuals includes costs incurred for technical training of military and contractor personnel participating in the Joint Task Group evaluations of new weapons prior to complete engineering release.

Development Activities

B&R: DP0704

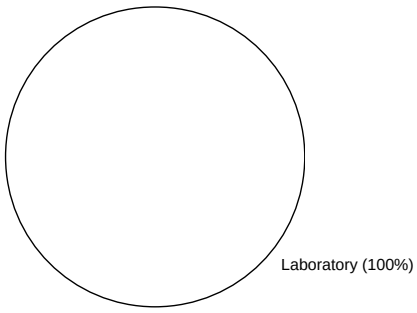
- Technical training of military and contractor personnel participating in the Joint Task Group evaluations of new weapons prior to complete engineering release.

Funding History



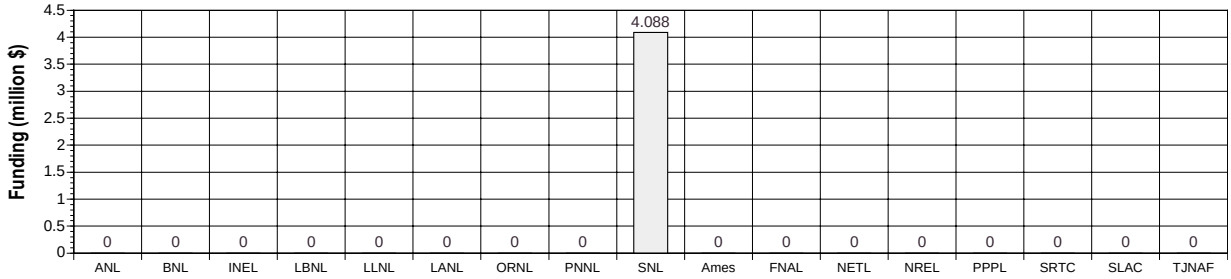
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Directed Stockpile Work

R&D Activity: Production Support

DOE Programs

Program: Defense Programs
Office: Nuclear Weapons Stockpile

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: None
Participating Laboratories: LANL

Strategic Goals and Objectives

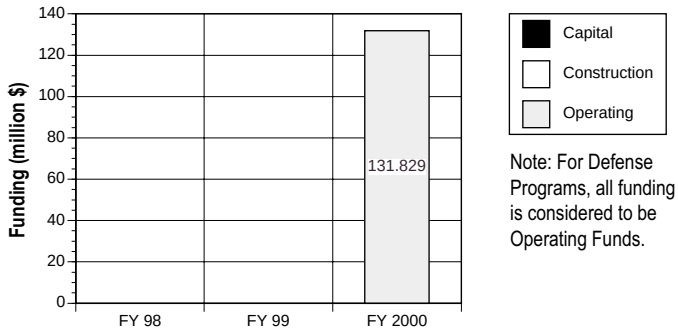
Production Support includes quality and production supervision and control, quality assurance, and production and process engineering.

Development Activities

B&R: DP0705

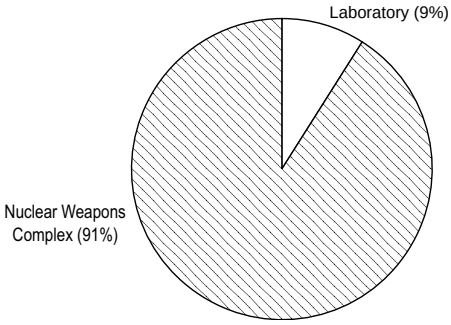
- Production Support including quality and production supervision and control, quality assurance, and production and process engineering at the Kansas City Plant.
- Production Support including quality and production supervision and control, quality assurance, and production and process engineering at the Los Alamos and Sandia National Laboratory.
- Production Support including quality and production supervision and control, quality assurance, and production and process engineering at the Savannah River Site.
- Production Support including quality and production supervision and control, quality assurance, and production and process engineering at the Y-12 Plant.

Funding History



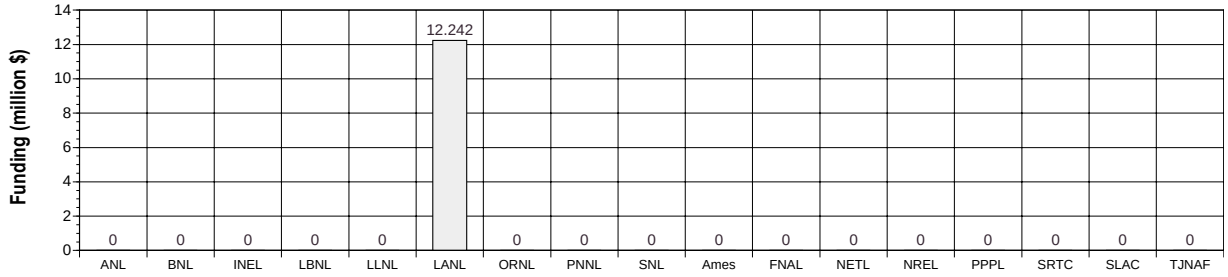
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



R&D Activity: Stockpile Research and Development

DOE Programs

Program: Defense Programs
Office: Stockpile Assessments and Certification

DOE Laboratory Performers

Principal Laboratories: LANL, SNL
Contributing Laboratories: LLNL
Participating Laboratories: None

Strategic Goals and Objectives

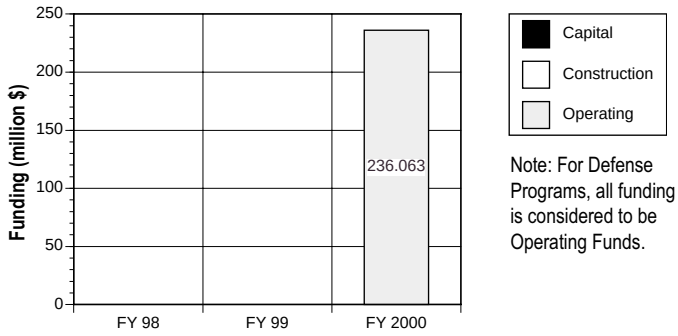
Stockpile Research and Development includes activities that are conducted in the following priority order: maintain system certification, respond to emerging problems or issues in a timely manner, support directive schedules, develop modern physics and engineering baselines, balance future refurbishment schedules against known requirements and available resources, develop refurbishment subsystem technologies, maintain flexibility to respond to new requirements, maintain the development capability to refurbish and design new weapons as required. Its goal is to ensure the operational safety, security, and reliability of the U.S. nuclear deterrent.

R&D Activities

B&R: DP0706

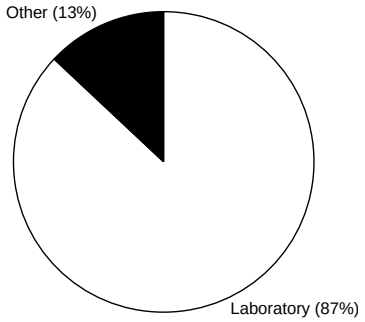
- Perform engineering and physics analyses to certify that weapons conform to the military requirements.
- Provide design interface with the DOE weapons production plants.
- Support assessments of the nuclear package and components of each weapon-system type to uncover design and manufacturing defects in all phases of production, provide early detection of safety and reliability problems caused by aging, and demonstrate compatibility between DoD and DOE interfaces
- Begin to develop a modern certification basis for each weapon system establishing a peer reviewed understanding and model of weapon system performance and safety including critical design margins and uncertainties.
- Provide long-term support of the stockpile with corrective maintenance and weapon component replacement and refurbishment as defined by the weapon Life Extension Programs.
- Research and development (R&D) applicable to specific weapon systems, as well as general R&D not yet directly tied to a weapon system.

Funding History



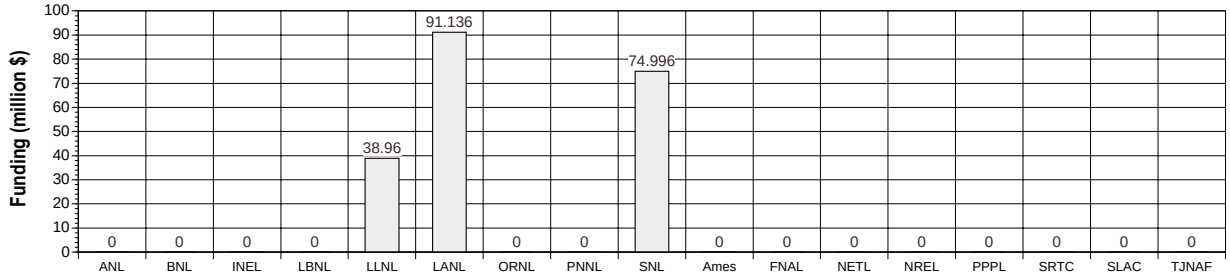
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Stockpile Science Campaigns

R&D Activity: Primary Certification

DOE Programs

Program: Defense Programs
Office: Defense Science

DOE Laboratory Performers

Principal Laboratories: LLNL
Contributing Laboratories: LANL
Participating Laboratories: None

Strategic Goals and Objectives

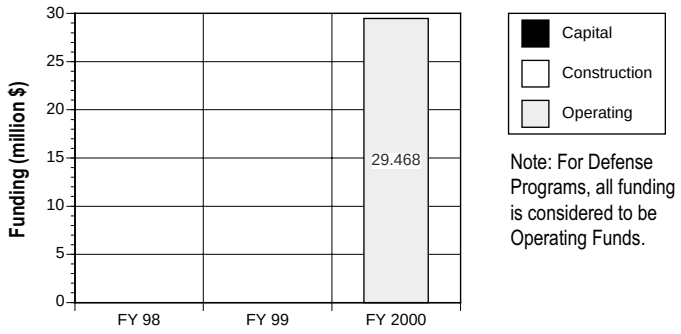
The Primary Certification Campaign supports experimental activities to develop and implement the ability to certify, without nuclear testing, rebuilt and aged primaries to within a stated yield level. The goal of this Campaign is to develop and demonstrate the tools required to certify the performance and safety of any rebuilt or aged primary to a specific yield.

R&D Activities

B&R: DP0801

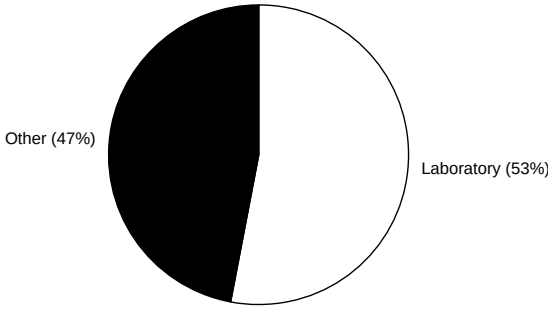
- Evaluate historical test data for archiving.
- Assess the effect of engineering and manufacturing technologies on pits.
- Conduct hydrodynamic experiments and test and validate computational models.
- Develop an improved dynamic mix model of a boosted nuclear explosion.
- Obtain equation-of-state and spall data from subcritical experiments. Develop thermochemically-based high explosive EOS.

Funding History



Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

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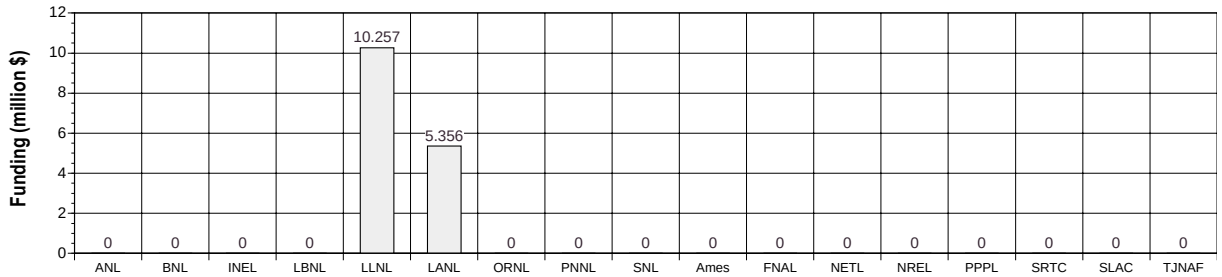


National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Stockpile Science Campaigns

R&D Activity: Dynamic Materials Properties

DOE Programs

Program: Defense Programs
Office: Defense Science

DOE Laboratory Performers

Principal Laboratories: LANL
Contributing Laboratories: LLNL
Participating Laboratories: SNL, ORNL

Strategic Goals and Objectives

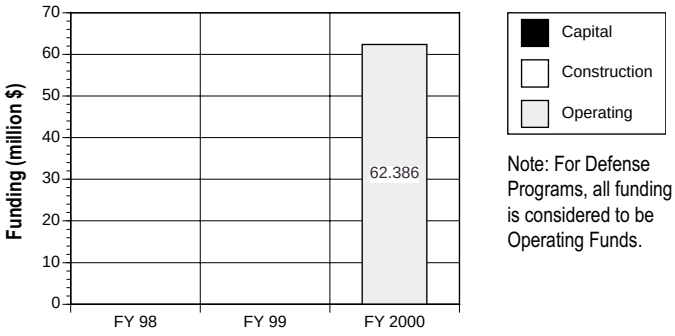
The Dynamic Materials Properties Campaign supports physics-based, experimentally-validated data and models of all stockpile materials at a level of accuracy commensurate with the requirements of the Primary and Secondary Certification Campaigns. The goal of this Campaign is to develop experimentally validated models of all materials that are essential to assess stockpile performance.

R&D Activities

B&R: DP0802

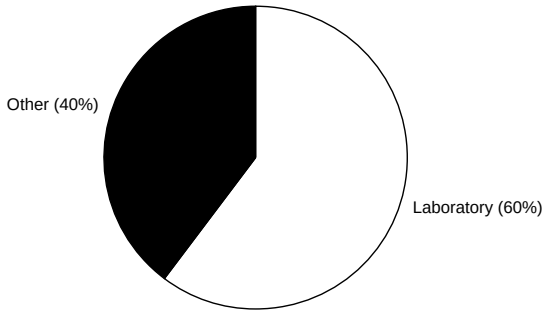
- Measurements of fundamental physical properties of deuterium.
- Interim Pu release equation-of-state, including refinements from Hugoniot data.
- Measurement of deuterium fluid phase diagram.
- Initiate experiments on the Joint Actinides Shock Physics Experimental Research (JASPER) facility at the Nevada Test Site.
- Initial dynamic measures of strength of materials.
- Experimental characterization of ejecta.
- Dynamic measurements of interfacial interactions in weapon materials.
- Initial tabular high explosive equation of state incorporating new overdriven data.
- Initial tabular foam description, including loading response and decomposition.

Funding History



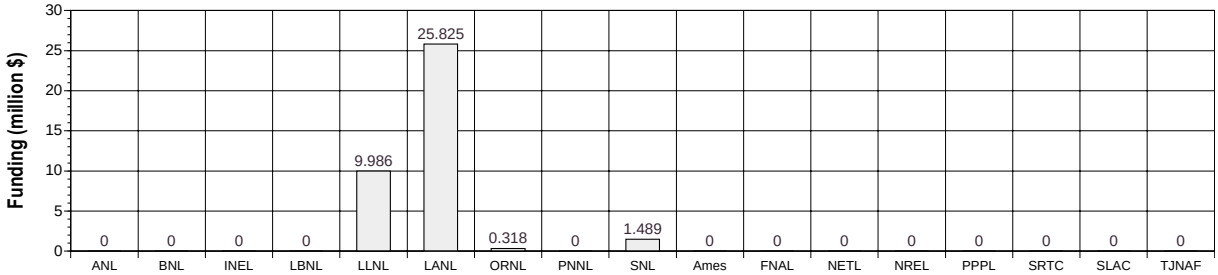
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Stockpile Science Campaigns

R&D Activity: Advanced Radiography

DOE Programs

Program: Defense Programs
Office: Defense Science

DOE Laboratory Performers

Principal Laboratories: LANL, LLNL
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

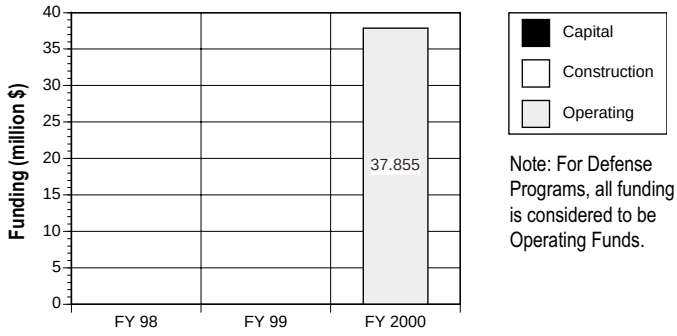
The Advanced Radiography Campaign supports research and development technologies for multi-view, time-gated images of imploding surrogate primaries, with sufficient spatial resolution to resolve uncertainties in primary performance. This utilizes advanced multi-time, multi-view, x-ray diagnostic techniques on DARHT, and further development and evaluation of proton radiography techniques. The goal of this Campaign is to provide the technology to obtain 3-D motion pictures of imploding surrogate primaries.

R&D Activities

B&R: DP0803

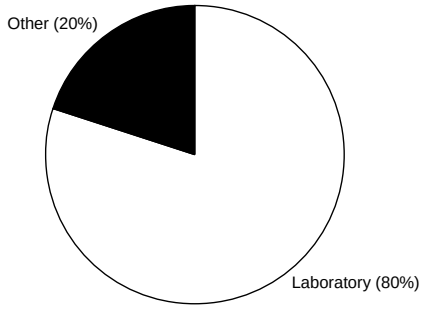
- Achieve optimum/minimum spot size on DARHT I target.
- Complete design of multi-pulse target for DARHT II.
- Complete evaluation of requirements for advanced radiography facilities.
- Identify preferred long-term material source.

Funding History



Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



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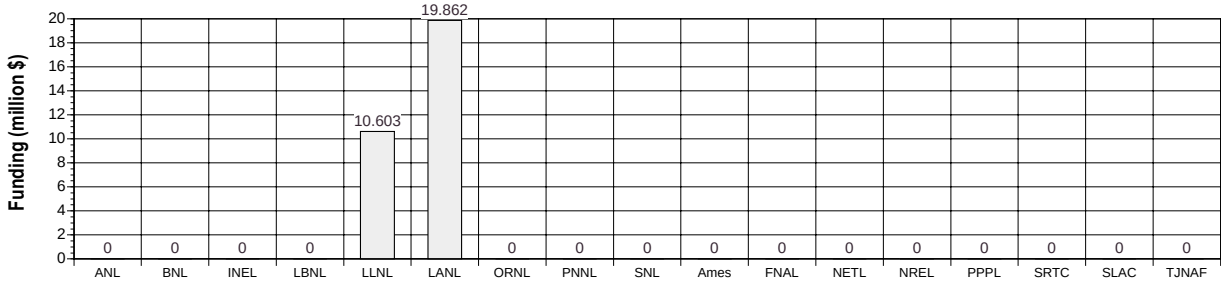


R&D Activity: Secondary Certification and Nuclear-Systems Margins

DOE Programs

Program: Defense Programs
Office: Defense Science

DOE Laboratory Performers

Principal Laboratories: LLNL
Contributing Laboratories: LANL
Participating Laboratories: SNL

Strategic Goals and Objectives

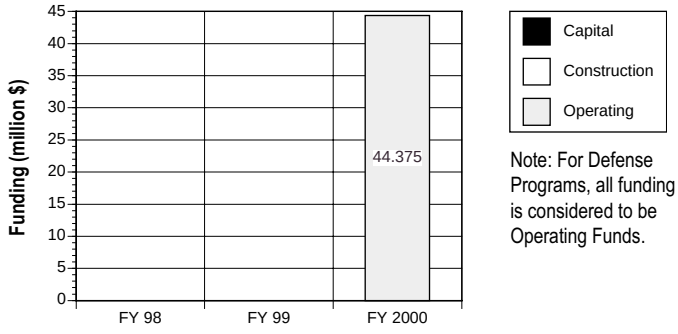
The Secondary Certification and Nuclear-Systems Margins Campaign includes theoretical understanding, along with experimental and computational activities which will determine the minimum primary factors necessary to produce a militarily effective weapon. The goal of this Campaign is to determine and document the minimum primary factors necessary to produce a militarily effective weapon.

R&D Activities

B&R: DP0804

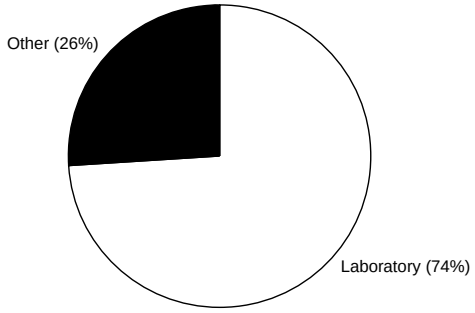
- Begin an evaluation of material-property uncertainties.
- Identify previously conducted underground tests and AGEX with relevant data, and complete analysis of those tests and experiments.
- Complete the reevaluation of primary-yield determination (radiochemistry and prompt diagnostics analysis).
- Complete the evaluation of material-property sensitivities on secondary performance.
- Identify issues and relevant underground test data associated with features and aging, and also important to marginal performance.

Funding History



Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

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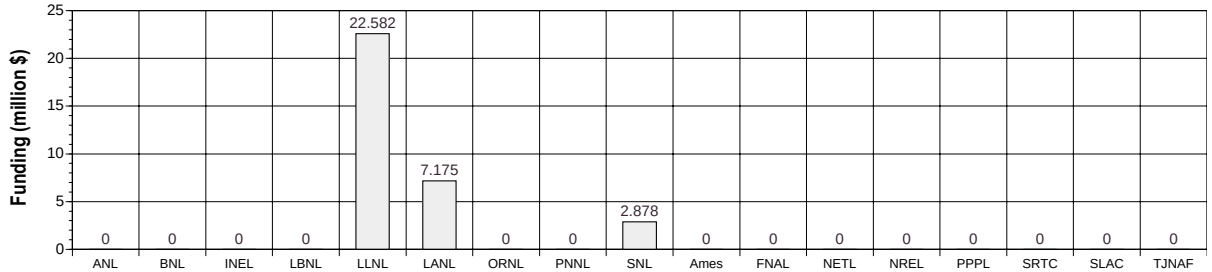


National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Stockpile Science Campaigns

R&D Activity: Inertial Confinement Fusion Ignition and High Yield

DOE Programs

Program: Defense Programs
Office: Defense Science

DOE Laboratory Performers

Principal Laboratories: LLNL, SNL
Contributing Laboratories: LANL
Participating Laboratories: None

Strategic Goals and Objectives

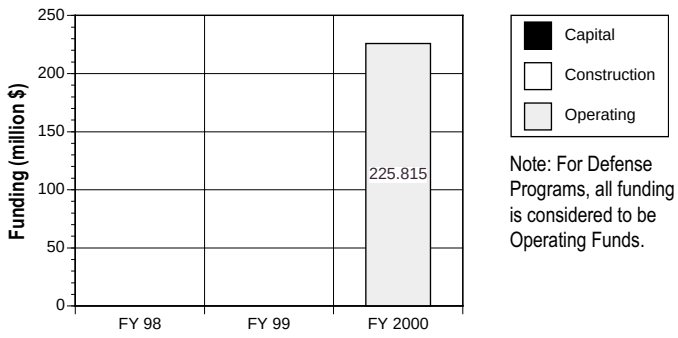
The Inertial Confinement Fusion Ignition and High Yield Campaign addresses high energy density physics issues for the nuclear weapons Stockpile Stewardship Program and develops a laboratory microfusion and high-yield capability for defense and energy applications. The goal of this Campaign is to start ignition physics implosion experiments (subject to NIF rebaselining), and the enhancement of experimental capabilities for stewardship.

R&D Activities

B&R: DP0810

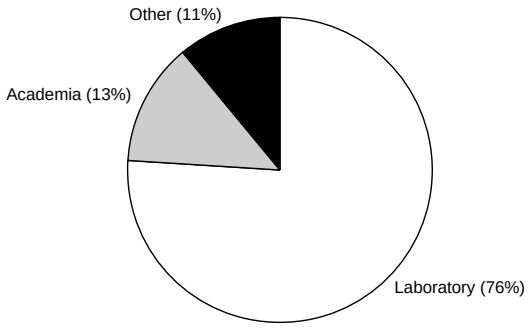
- Advanced capabilities to improve ICF target physics necessary to achieve ignition on NIF, including measurement of the deuterium equation-of-state, designs for higher efficiency hohlraums, improved capsule designs, and the activation of the Omega cryogenic target handling system.
- Direct drive illumination better than 1%.
- Complete Z beamlet x-ray backlighter for stockpile stewardship experiments on Z.
- Start national cryogenic target system project.
- Evaluate NIF hohlraum energetics and laser core diagnostic options.
- Perform approximately 1600 experiments on Omega and Z in support of Ignition and Weapons Physics Campaigns goals.
- Perform high-density cryogenic implosions on Omega and complete a hydrodynamic simulation code for 1D, 2D, and 3D direct drive target performance evaluations.
- Complete conceptual designs for NIF shock-timing and symmetry diagnostics.

Funding History



Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



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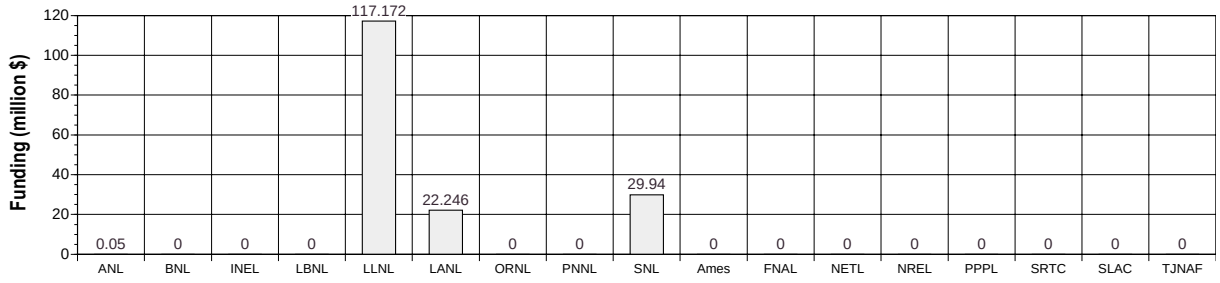


National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Stockpile Science Campaigns

R&D Activity: Certification in Hostile Environments

DOE Programs

Program: Defense Programs
Office: Defense Science

DOE Laboratory Performers

Principal Laboratories: SNL
Contributing Laboratories: LLNL
Participating Laboratories: None

Strategic Goals and Objectives

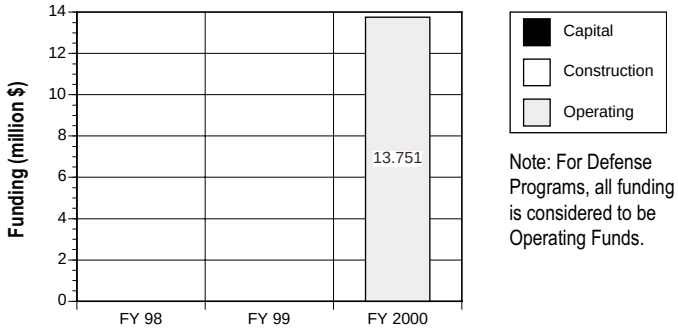
The Certification in Hostile Environments Campaign develops the certification tools and microelectronics technologies required to ensure that refurbished weapons meet the Stockpile Target Sequence hostile environments requirements. The goal of the Campaign is to demonstrate the capability to support enduring stockpile certification and life extension without underground tests, through radiation hardening and modeling and validation.

R&D Activities

B&R: DP0807

- Begin analysis of DSW pit tests on the W76 and W88.
- Define set of above- and below-ground nuclear test data to be used to benchmark modern code calculation.
- Improve Saturn x-ray source to produce environments required for effects testing.

Funding History



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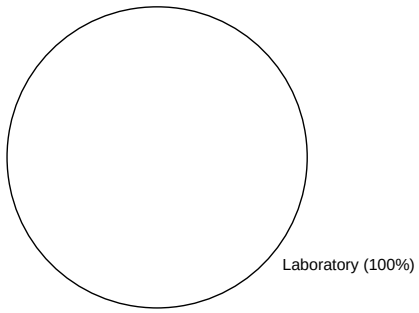
Laboratory-Academia-Industry Participation



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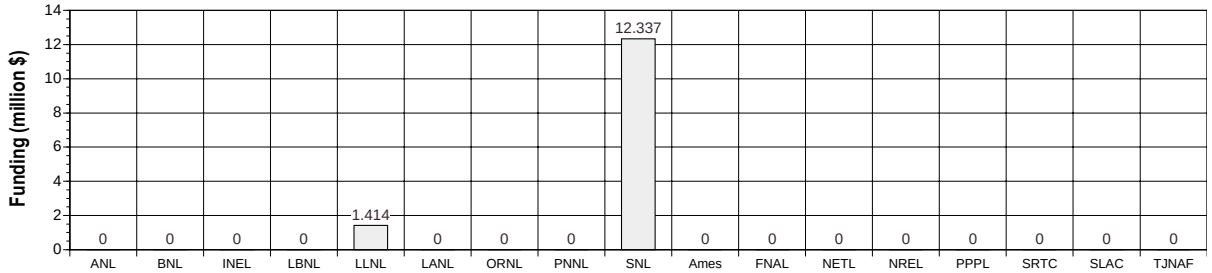
Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Advanced Simulation and Computing

R&D Activity: Advanced Simulation and Computing

DOE Programs

Program: Defense Programs
Office: Advanced Simulation and Computing

DOE Laboratory Performers

Principal Laboratories: LLNL, LANL, SNL
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

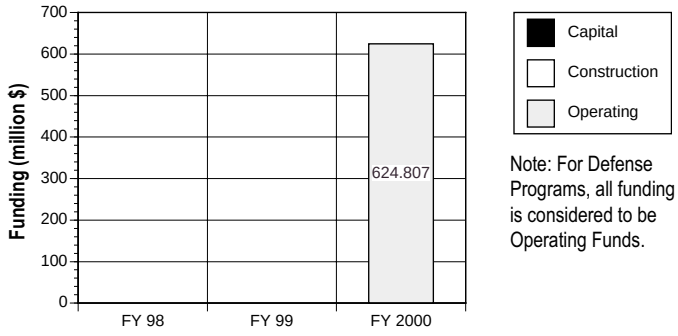
The Advanced Simulation and Modeling Campaign develops next generation of higher performance software required to certify the performance and safety of the stockpile along with the capabilities to further demonstrate, evaluate, assess, and document the predictive capabilities of the codes and their underlying models. The goal of this Campaign is to provide validated 3-D, high fidelity physics, full-system simulation codes required for engineering, safety, and performance analyses of the stockpile.

R&D Activities

B&R: DP0811

- Employ formal software engineering methods for code verification.
- Validate prototype codes by comparison with both integral experiments and phenomenological tests.
- Develop advanced materials and physics models and implement advanced models in simulation codes.

Funding History



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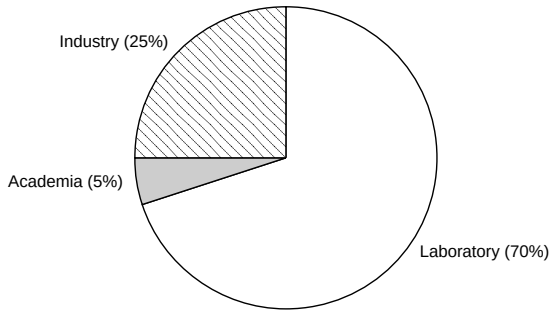
Laboratory-Academia-Industry Participation



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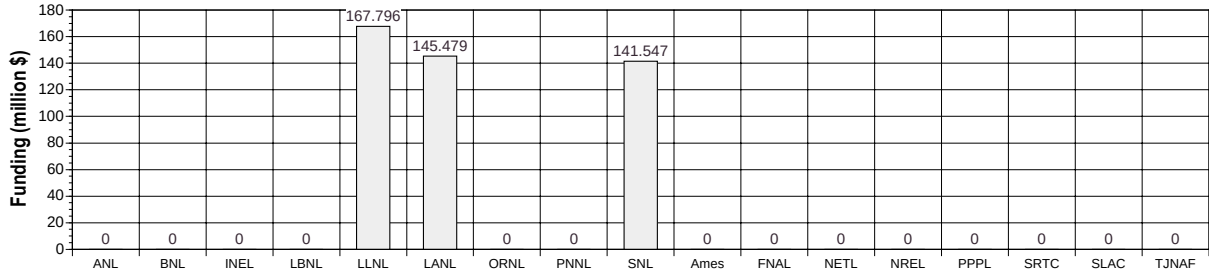


National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Stockpile Assessments and Certification

R&D Activity: Weapon Systems Engineering Certification

DOE Programs

Program: Defense Programs
Office: Stockpile Assessments and Certification

DOE Laboratory Performers

Principal Laboratories: SNL
Contributing Laboratories: LANL
Participating Laboratories: LLNL

Strategic Goals and Objectives

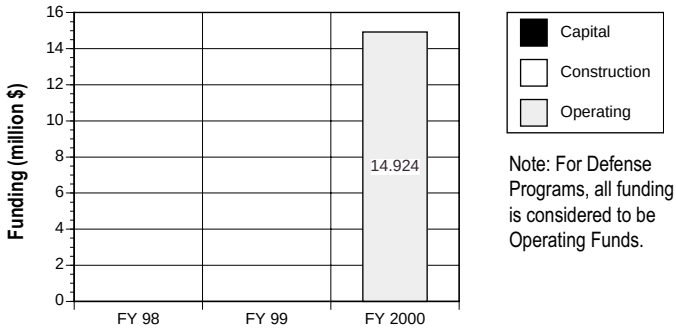
The Weapon System Engineering Certification Campaign establishes science-based certification methods that quantify performance and uncertainties of the stockpile and reduce cost, drive test configurations to most critical event environments, and maximize understanding. The goal of this Campaign is to produce and demonstrate the methodology and metrics to certify a weapon system in the flight and abnormal environments using modeling and simulation tools.

R&D Activities

B&R: DP0806

- Define modeling and simulation based certification requirements for the flight and abnormal environments.
- Begin W-76 flight models (version 1.0) validation.
- Complete design for first enhanced RV/RB flight-test article.

Funding History



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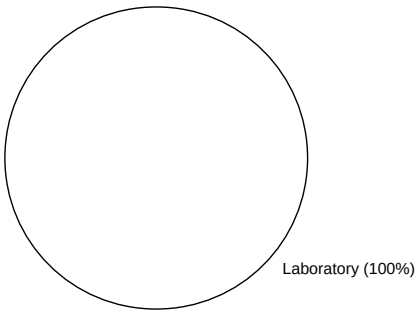
Laboratory-Academia-Industry Participation



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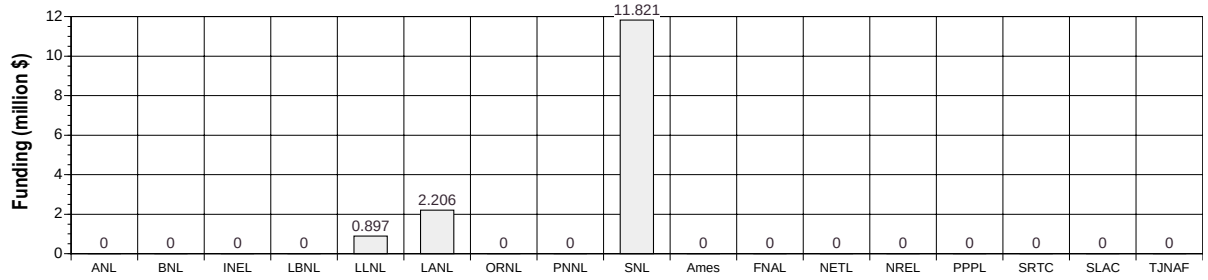


National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Stockpile Assessments and Certification

R&D Activity: Enhanced Surety

DOE Programs

Program: Defense Programs
Office: Nuclear Weapons Surety - Stockpile Assessments and Certification

DOE Laboratory Performers

Principal Laboratories: SNL
Contributing Laboratories: None
Participating Laboratories: LANL, LLNL

Strategic Goals and Objectives

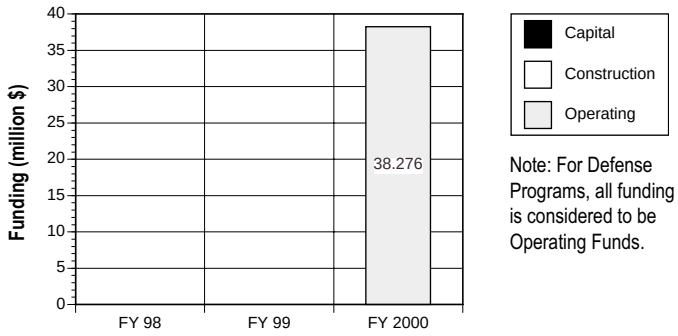
The Enhanced Surety Campaign will provide validated technology for inclusion in the stockpile refurbishment program to assure modern nuclear safety standards are fully met and to provide a new level of use-denial performance. The goal of this Campaign is to demonstrate enhanced surety and initiation options for the entire stockpile.

R&D Activities

B&R: DP0805

- Develop Full Scale Engineering Development (FSED)-ready technologies for improved surety options for the W80 and W76 systems using current technologies and capabilities.

Funding History



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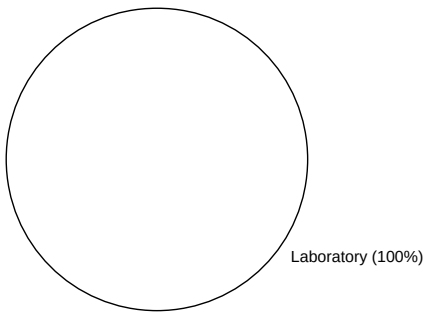
Laboratory-Academia-Industry Participation



FY 2000 Data

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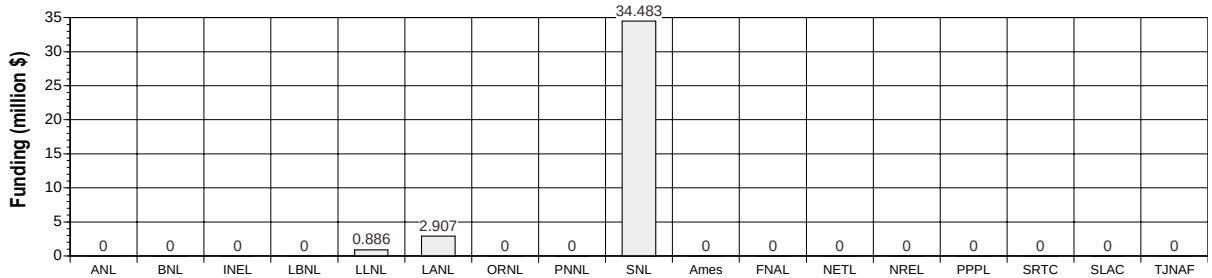


National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Stockpile Assessments and Certification

R&D Activity: Enhanced Surveillance

DOE Programs

Program: Defense Programs
Office: Nuclear Weapons Stockpile - Stockpile Assessments and Certification

DOE Laboratory Performers

Principal Laboratories: LANL,SNL, LLNL
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

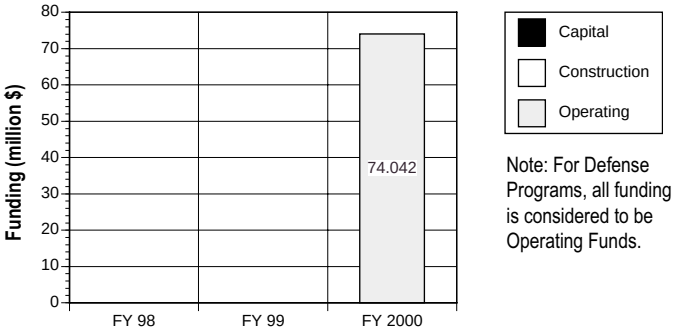
The Enhanced Surveillance Campaign will provide a validated basis to determine if or when components must be replaced. The goals of this Campaign are to: provide documented component lifetime assessments; have predictive tools in place to identify aging defects prior to any impact to safety, reliability, or performance; develop tools to identify all birth defects in new materials prior to introduction into the stockpile; and meet defined Stockpile Life Extension Program (SLEP) and certification-driven surveillance requirements.

R&D Activities

B&R: DP0808

- Conduct vulnerability tests on oldest pits available.
- Benchmark canned subassembly corrosion models with simulated aging tests.
- Complete experiments to confirm HE aging mechanisms and benchmark model.
- Predict performance of highest risk nonnuclear energetic components.

Funding History



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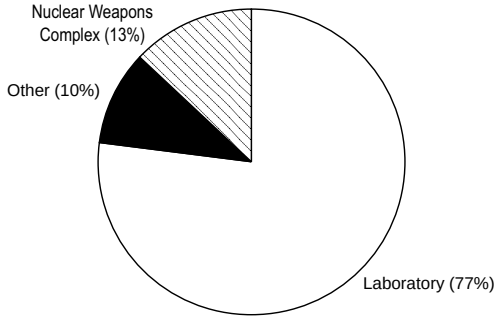
Laboratory-Academia-Industry Participation



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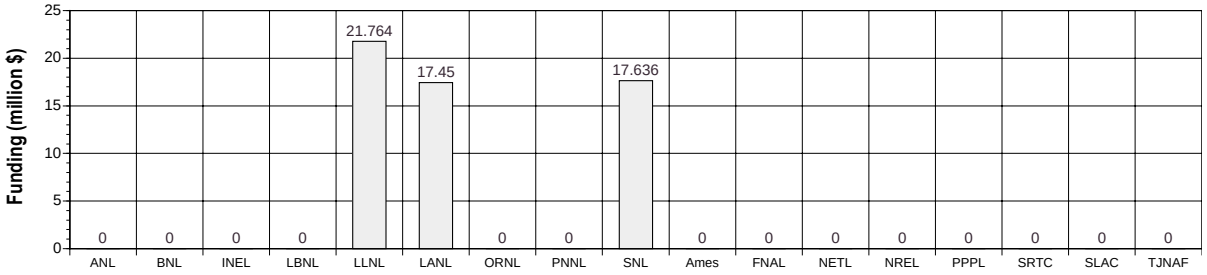


National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Production and Manufacturing Science and Technology

R&D Activity: Advanced Design and Production Technologies

DOE Programs

Program: Defense Programs
Office: Nuclear Weapons Stockpile - Stockpile Assessments and Certification

DOE Laboratory Performers

Principal Laboratories: SNL
Contributing Laboratories: LANL
Participating Laboratories: LLNL

Strategic Goals and Objectives

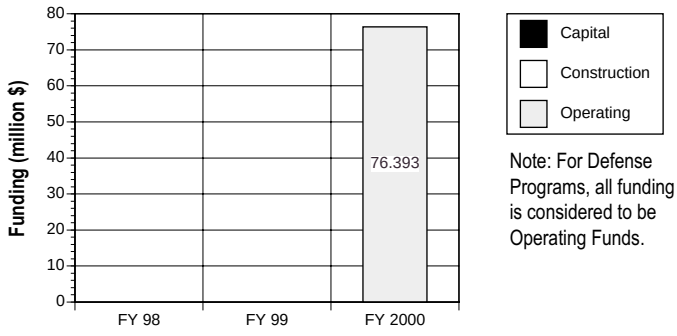
The Advanced Design and Production Technologies (ADAPT) Campaign will integrate and systematically deploy capabilities to deliver qualified refurbishment products upon demand. This will be accomplished by developing multiple, fast turnaround engineering options through virtual prototypes and implementing modern product data management and collaboration tools. The goal of this Campaign is to provide the capability to deliver qualified stockpile life extension program refurbishment products upon demand at one-half cost, one-half the current time and with zero stockpile defects.

R&D Activities

B&R: DP0809

- Provide secure, authenticated, high speed network that is available at designer's/producer's desktop.
- Perform pilot project in Model-Based Engineering and Manufacturing (MBE/M).
- Demonstrate processes for fabricating and packaging high shock environment miniaturized circuits.
- Continue robotics research.
- Continue planning for deployment of integrated design/manufacturing models and process development/agile manufacturing activities.

Funding History



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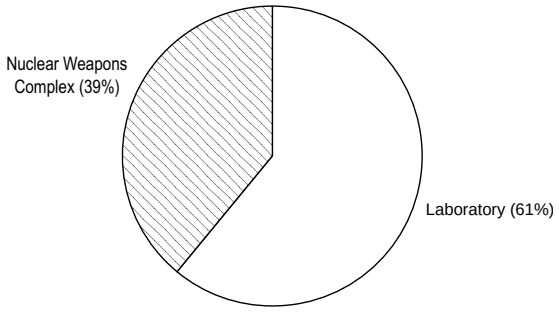
Laboratory-Academia-Industry Participation



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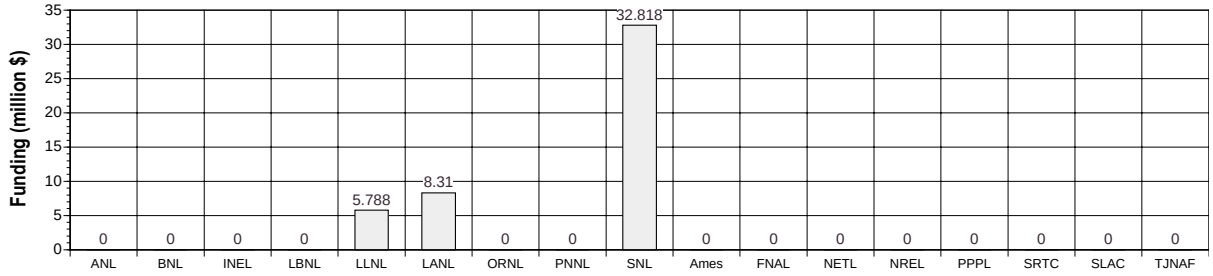
Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Production Readiness

R&D Activity: Pit Manufacturing Readiness

DOE Programs

Program: Defense Programs
Office: Pit Production

DOE Laboratory Performers

Principal Laboratories: LANL
Contributing Laboratories: None
Participating Laboratories: LLNL

Strategic Goals and Objectives

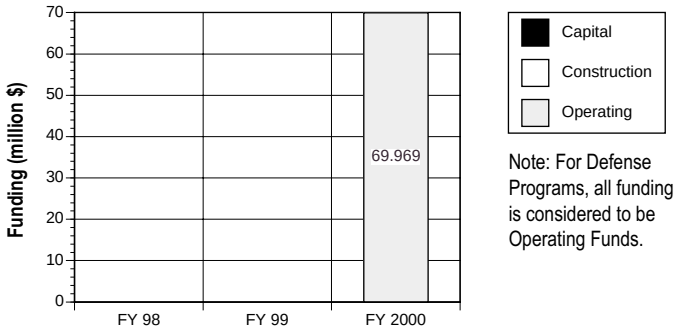
The Pit Manufacturing Readiness Campaign includes: operating support and the procurement of equipment for the reestablishment of a war reserve pit production capability and a limited production capacity at LANL; manufacture of a quantity of pits for certification and ultimate placement into the nuclear weapons stockpile; and planning and implementing of a manufacturing capacity for long-term support of the stockpile. The goal of this Campaign is to develop an automated, expandable, robust manufacturing capability to produce stockpiles and new-design pits, without underground testing, within 19 months of the establishment of a need for a new pit, and with a stockpile life greater than the weapon system.

R&D Activities

B&R: DP0812

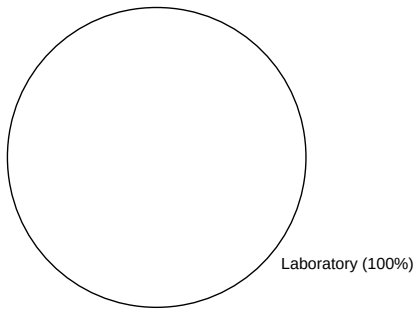
- Continue manufacture of development pits leading toward the manufacture of a certifiable W88 pit.

Funding History



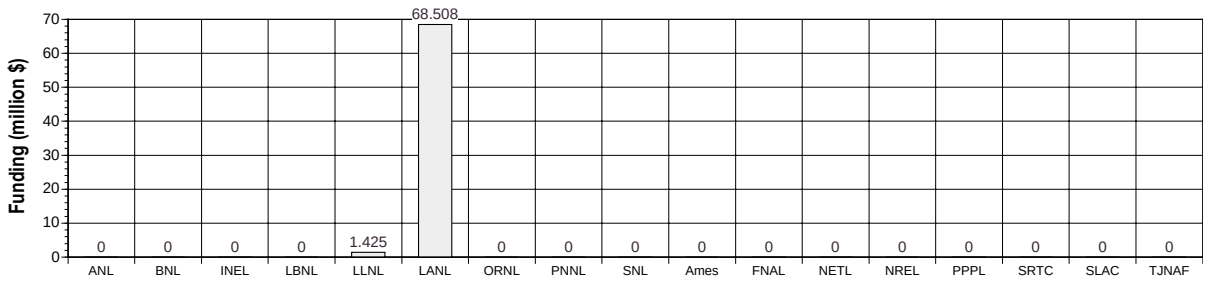
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Production Readiness

R&D Activity: Materials Readiness

DOE Programs

Program: Defense Programs
Office: Nuclear Weapons Stockpile

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: LANL
Participating Laboratories: SNL

Strategic Goals and Objectives

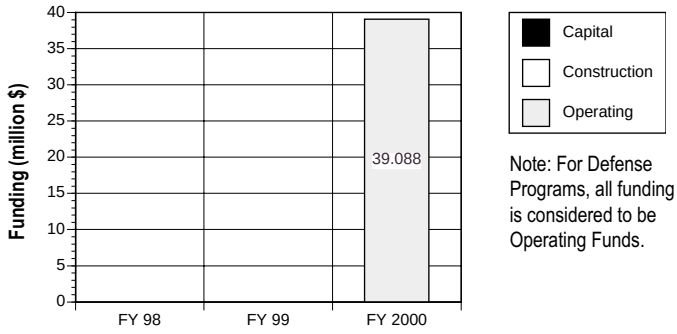
Material Readiness supports the consolidation of weapon-grade HEU resources at Y-12. Provides critical inventory information, processes, and technologies to ensure availability of nuclear and nonnuclear special materials to support SLEP rebuilds and component production campaigns. Provides modern storage facilities, monitoring instrumentation and containers for enhanced protection of national security materials. Its goal is to develop a fully integrated material management system supporting strategic material needs with either stockpiled material or the capability to produce new material.

Development Activities

B&R: DP0816

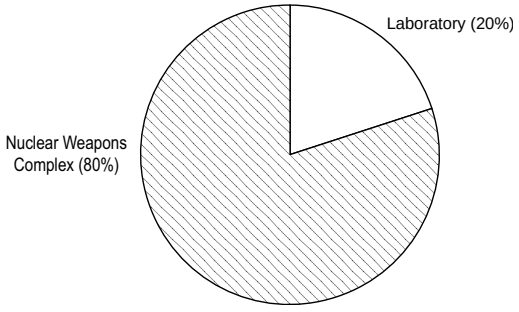
- Complete a survey of national security materials and requirements.
- Complete a gap analysis and identify a strategy or program elements for filling the gaps.

Funding History



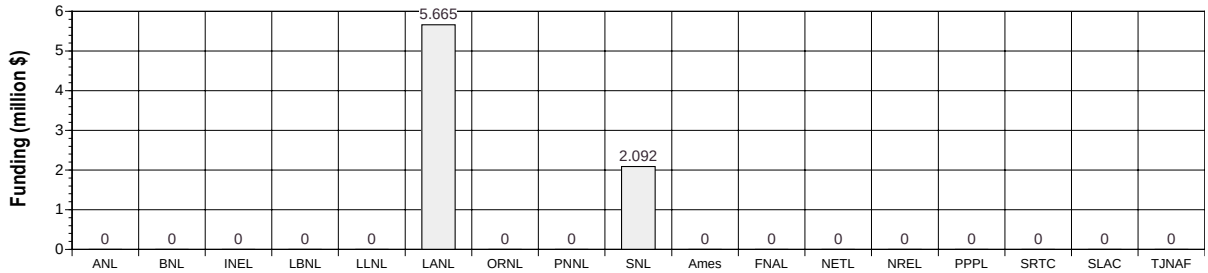
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Production Readiness

R&D Activity: Tritium Readiness

DOE Programs

Program: Defense Programs
Office: Tritium Production

DOE Laboratory Performers

Principal Laboratories: LANL, PNNL
Contributing Laboratories: ANL
Participating Laboratories: ORNL, NETL, BNL, LLNL

Strategic Goals and Objectives

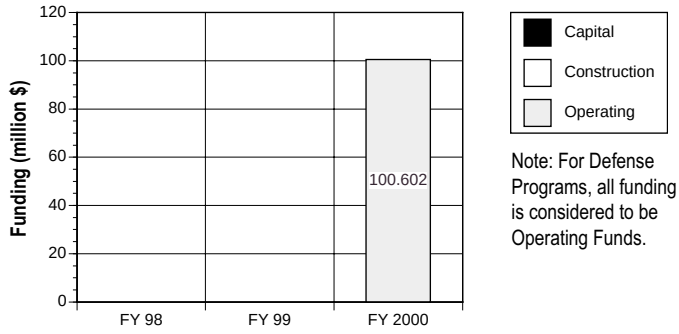
The Tritium Readiness Campaign will implement the Secretarial Record of Decision, which selected the Commercial Light Water Reactor option as the primary technology for the production of tritium. Its goal is to establish the production and operations systems to produce tritium in a commercial reactor, so that tritium can be delivered to the stockpile.

R&D Activities

B&R: DP0817

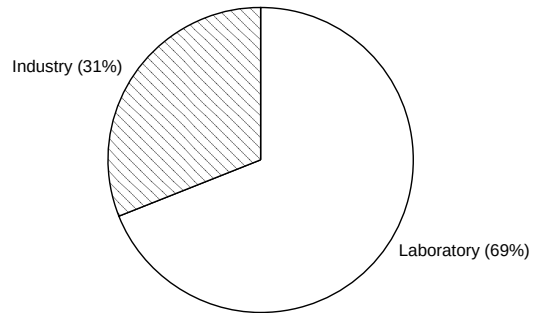
- Establish contracts with vendors for the procurement of Tritium Producing Burnable Absorber Rod (TPBAR) components, final assembly and long-term transportation services.
- Submit documents to initiate the process to amend the Nuclear Regulatory Commission operation license of the Tennessee Valley Authority's Watts Bar and Sequoyah reactors.

Funding History



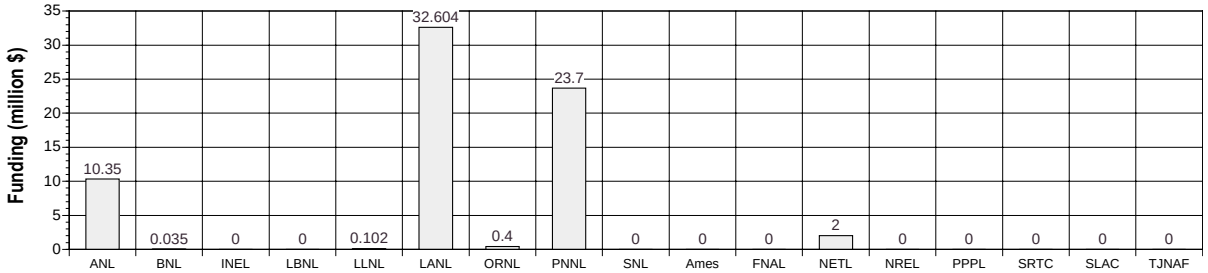
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Readiness in Technical Base and Facilities

R&D Activity: Operation of Facilities

DOE Programs

Program: Defense Programs
Office: All

DOE Laboratory Performers

Principal Laboratories: LANL
Contributing Laboratories: SNL
Participating Laboratories: LLNL

Strategic Goals and Objectives

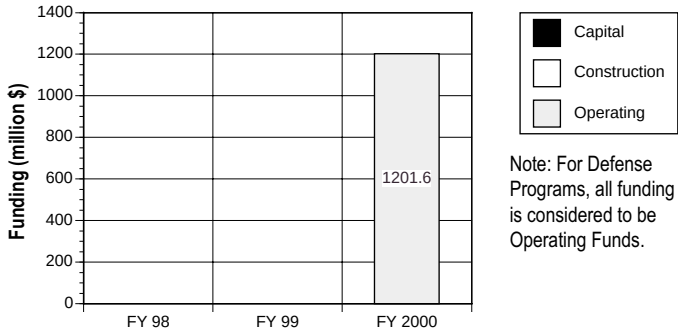
Operations of Facilities is defined as DP's share of the cost to operate and maintain DP-owned programmatic facilities in a "warm stand-by" mode. DP-owned facilities primarily support campaigns and DSW and are usually over 50% funded by DP budget. "Warm standby" is a state of readiness at which each facility is prepared to execute programmatic tasks identified in the campaigns and DSW. This category includes DP's share of the cost of all structures, equipment, systems, materials, procedures and personnel necessary to provide program sponsors with a facility that is safe, secure, reliable and "ready for operations."

R&D Activities

B&R: DP0901

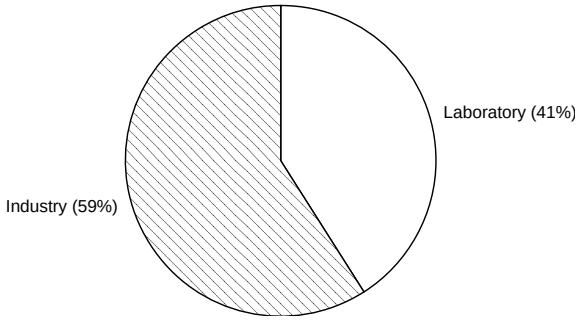
- None.

Funding History



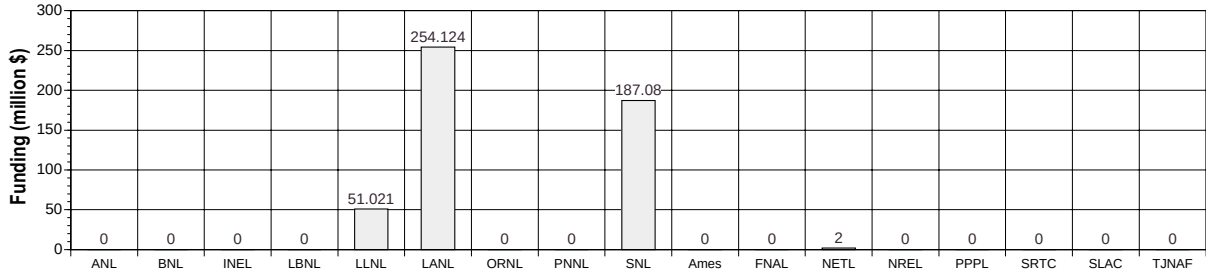
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Readiness in Technical Base and Facilities

R&D Activity: Program Readiness

DOE Programs

Program: Defense Programs
Office: All

DOE Laboratory Performers

Principal Laboratories: SNL
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

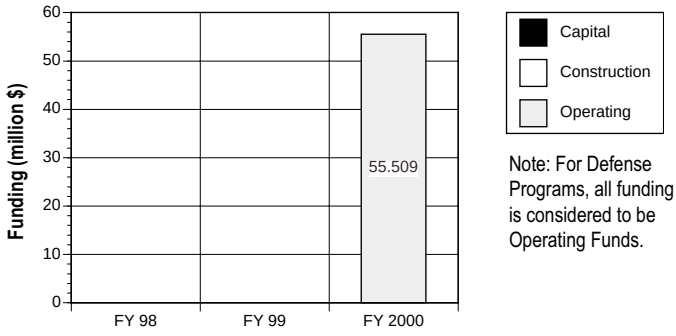
Program Readiness includes activities that support more than one facility, Campaign, or DSW activity, but are essential to achieving the program's objectives. The activities may vary from site to site due to the inherent differences in site activities and organizational structure. An example of a Program Readiness activity would be inertial fusion target fabrication in support of weapons experiments.

R&D Activities

B&R: DP0902

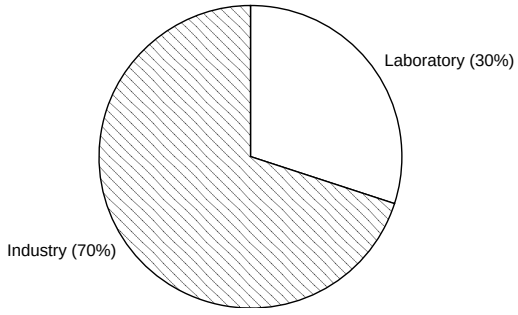
- None.

Funding History



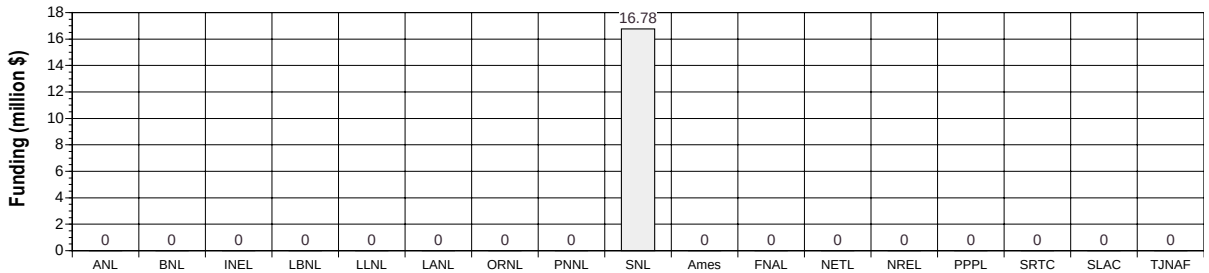
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Readiness in Technical Base and Facilities

R&D Activity: Material Recycle and Recovery

DOE Programs

Program: Defense Programs
Office: Operations and Readiness

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

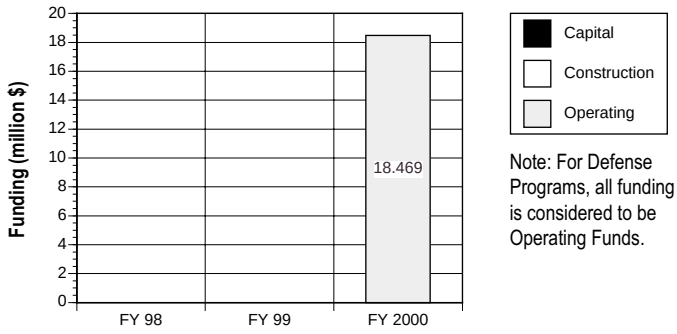
Material Recycle and Recovery includes the recycle and recovery of plutonium, enriched uranium, and tritium from fabrication and assembly operations, limited life components, and components from dismantled weapons. It involves the process of recycling and purifying these materials to meet specifications for safe, secure, and environmentally acceptable storage, including meeting the directive schedule for refilling weapon tritium reservoirs.

R&D Activities

B&R: DP0904

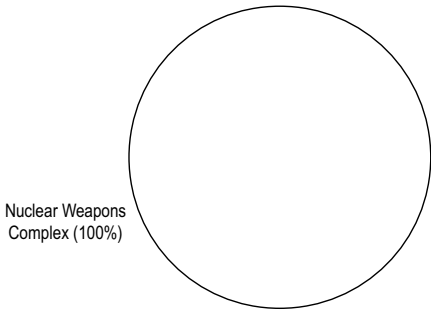
- None.

Funding History



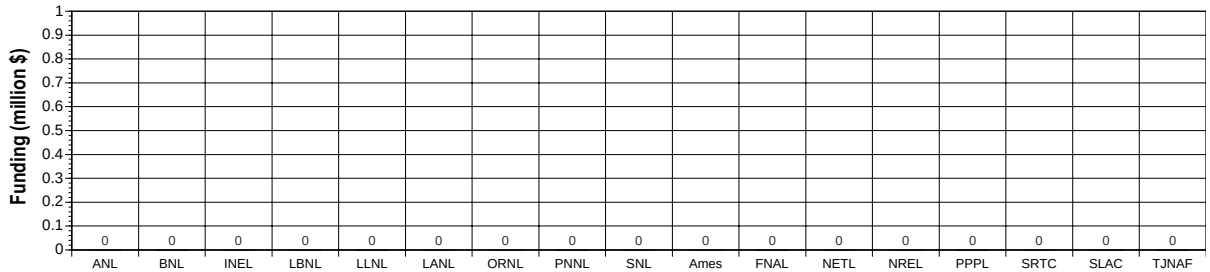
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Readiness in Technical Base and Facilities

R&D Activity: Containers

DOE Programs

Program: Defense Programs
Office: Operations and Readiness

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: LLNL
Participating Laboratories: None

Strategic Goals and Objectives

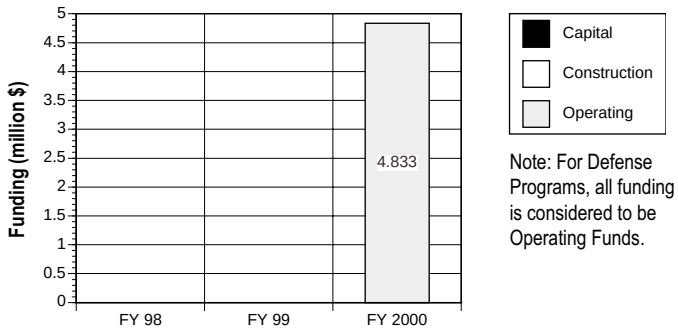
Containers includes research and development, design, re-certification and maintenance, off-site transportation certification of component containers in accordance with Federal regulations, test and evaluation, production/procurement, fielding and maintenance, and decontamination and disposal to provide adequate quantities of containers to support the nuclear weapons mission.

R&D Activities

B&R: DP0905

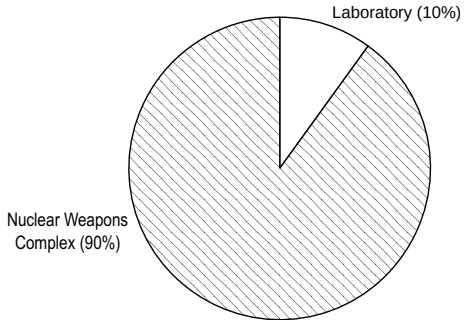
- Development of containers that use improved technologies.

Funding History



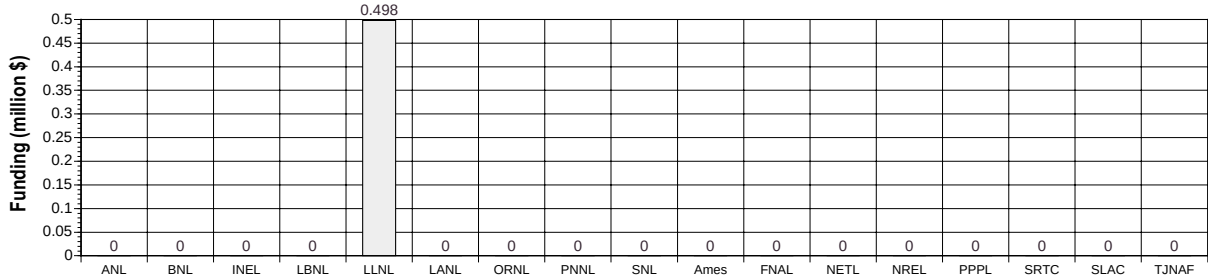
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Readiness in Technical Base and Facilities

R&D Activity: Storage

DOE Programs

Program: Defense Programs
Office: Operations and Readiness

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

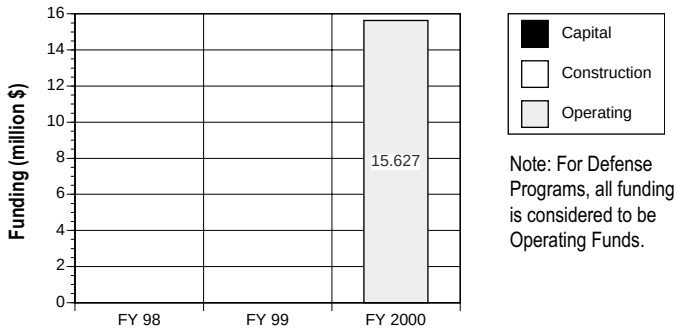
Storage provides for the storage of weapons material and components.

R&D Activities

B&R: DP0906

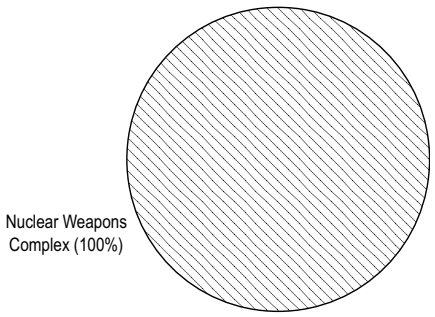
- None.

Funding History



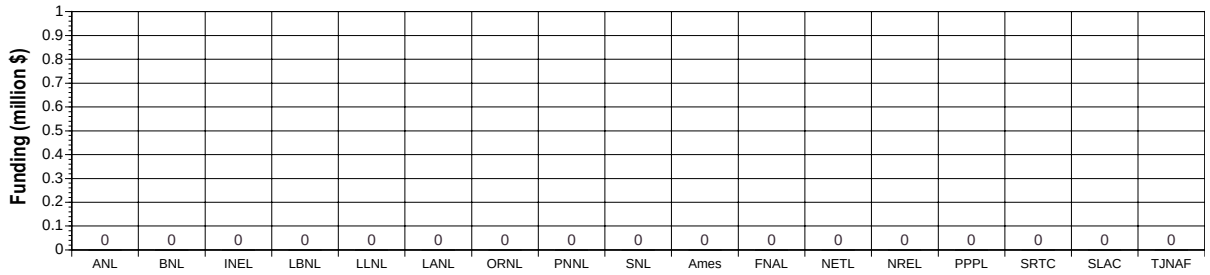
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



R&D Activity: Weapons Incident Response

DOE Programs

Program: Defense Programs
Office: Emergency Response

DOE Laboratory Performers

Principal Laboratories: LANL, LLNL
Contributing Laboratories: SNL
Participating Laboratories: None

Strategic Goals and Objectives

Weapons Incident Response comprises the Nuclear Emergency Search Team (NEST) and the Accident Response Group (ARG). NEST consists of engineers, scientists, and other technical specialists from DOE's national laboratories, and other contractors who support the Federal Bureau of Investigation (FBI) in addressing nuclear-weapon or radiological threats, responding within four hours of notification.

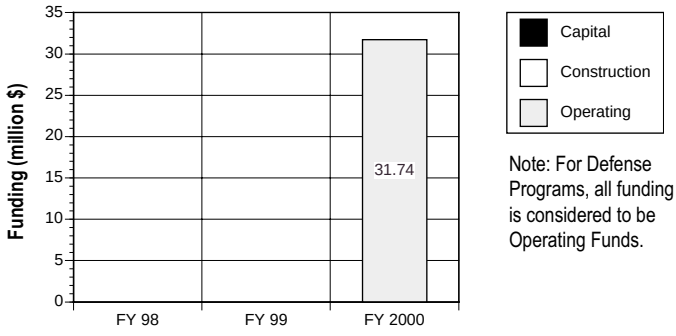
ARG comprises weapons designer and engineers, physical scientists, and other technical specialists from across the DOE weapon complex, together with specially designed equipment that can be collectively or independently deployed to provide timely assistance to peacetime accidents and significant incidents involving nuclear weapons, throughout the world.

R&D Activities

B&R: DP0909

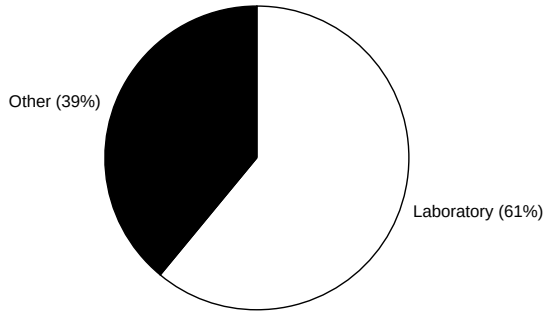
- None.

Funding History



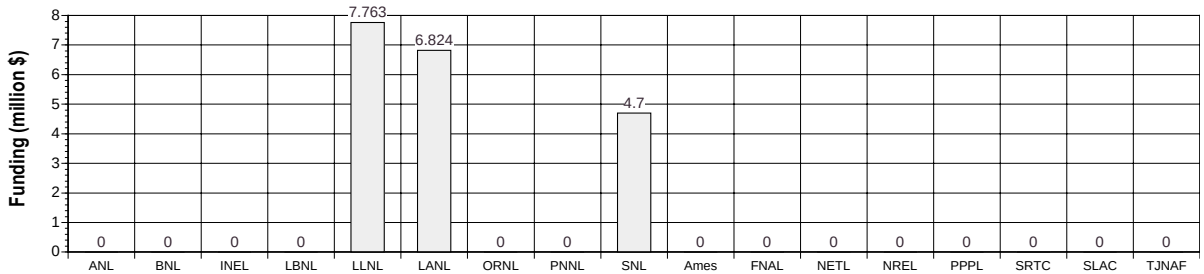
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Maintaining the Nuclear Deterrent**

Program Area: Readiness in Technical Base and Facilities

R&D Activity: Construction

DOE Programs

Program: Defense Programs
Office: All

DOE Laboratory Performers

Principal Laboratories: LANL, LLNL, SNL
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

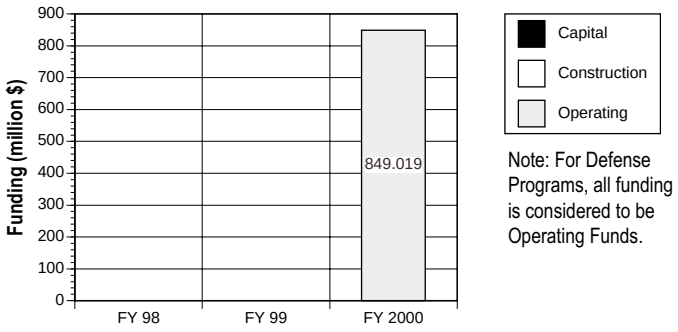
Capital construction at Defense Programs sites.

R&D Activities

B&R: 39DP09

- None.

Funding History



Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation

Fiscal Year 2000 Funding Profile

Program Area: Secure Transportation Asset

R&D Activity: Secure Transportation Asset

DOE Programs

Program: Defense Programs
Office: Secure Transportation Asset

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

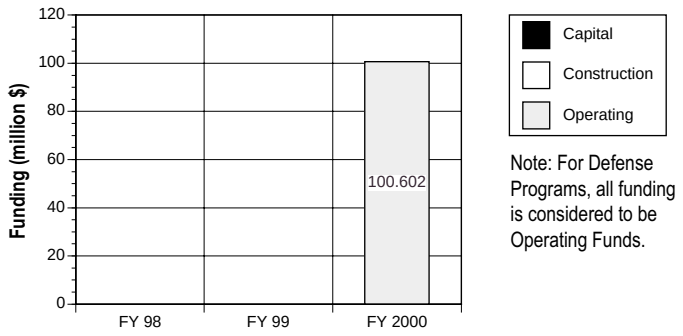
The Secure Transportation Asset provides support to all of the DOE Strategic Plan objectives requiring the safe, secure transport of nuclear weapons, special nuclear material, selected non-nuclear weapons components, limited-life components and other Department materials. These DOE Strategic Plan objectives are managed by programs throughout the Department including Defense Programs, Environmental Restoration and Waste Management, Fissile Materials Disposition and Nuclear Energy.

R&D Activities

B&R: DP0602

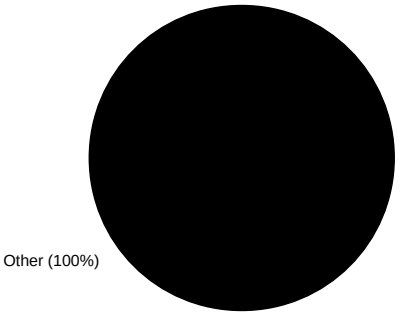
- Provide for the transportation of Department materials in a safe and secure manner.
- Provide for the maintenance and repair of the transporter fleet.
- Provide for necessary communications and communications equipment.
- Provide for upgrades to equipment and escort vehicles required to upgrade the security posture of the Secure Transportation Asset Provide the replace of the Safe Secure Transport (SST) with the SafeGuards Transporter on an accelerated basis.

Funding History



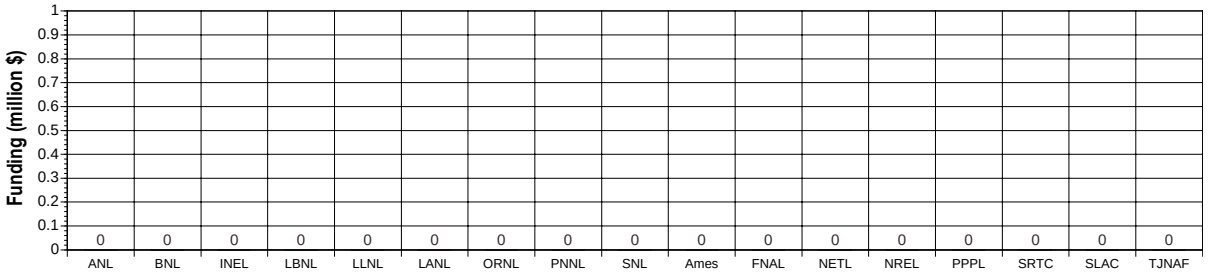
Note: For Defense Programs, all funding is considered to be Operating Funds.

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



R&D Activity: Monitoring Nuclear Explosions

DOE Programs

Program: Defense Nuclear Nonproliferation (NN)
Office: Office of Nonproliferation Research and Engineering (NN-20)

DOE Laboratory Performers

Principal Laboratories: LANL, SNL
Contributing Laboratories: None
Participating Laboratories: ANL, LBNL, LLNL, PNNL

Strategic Goals and Objectives

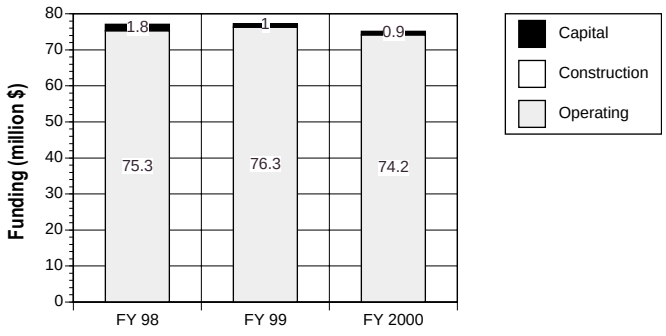
- Develop technologies and systems, and the attendant scientific basis thereof, to enable remote detection, location, identification, and attribution of nuclear-test-ban treaty and moratoria violations with sufficient timeliness and confidence to permit effective national and international assessment and verification.
- Develop technologies and systems to remotely monitor nuclear explosions not related to testing to meet warfighting and other national needs.

R&D Activities

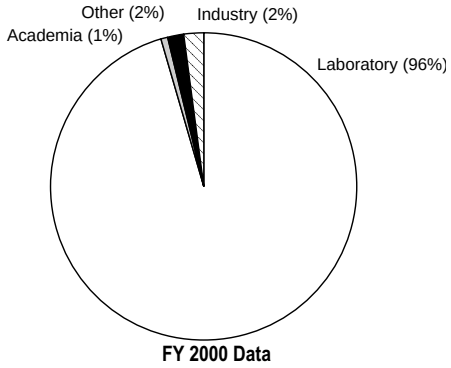
Monitoring Nuclear Explosions (B&R: GC0402000, GC0404000, GC0401000)

- Develop technologies for opticlal, electromagnetic-pulse, x-ray, gamma-ray, and neutron satellite-based sensing of nuclear device explosions that occur in the atmosphere and in space
- Produce actual operational optical, x-ray, gamma-ray, and neutron sensors for nuclear explosion monitoring from satellites
- Develop technolgies for seismic, radionuclide, hydroacoustic, and infrasound ground-based sensing of nuclear device explosions that occur undergound, underwater, and in the atmosphere

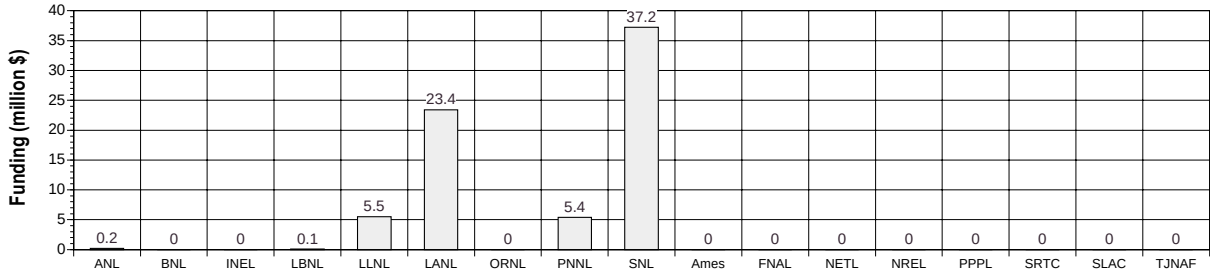
Funding History



Laboratory-Academia-Industry Participation



Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Monitoring Nuclear Treaties and Agreements

Activity: HEU Transparency Implementation

DOE Programs

Program: Defense Nuclear Nonproliferation (NN)
Office: Office of International Nuclear Safety and Cooperation (NN-30)

DOE Laboratory Performers

Principal Laboratories: LLNL, ORNL
Contributing Laboratories: SNL
Participating Laboratories: ANL, BNL, LANL, CH, RSL, PNNL

Strategic Goals and Objectives

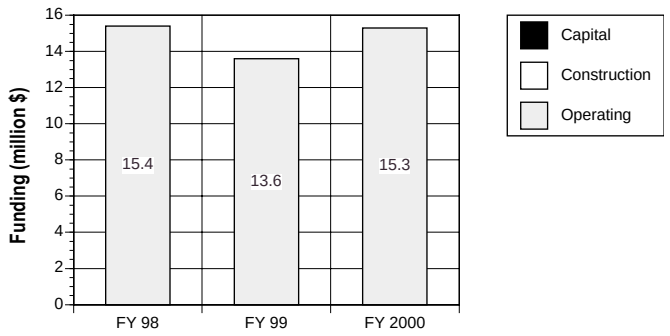
- Remove 500 metric tons of weapons-grade (HEU) derived from inventory of dismantled Russian nuclear weapons and permanently convert the fuel to LEU for use in US commercial nuclear power reactors.

Activities

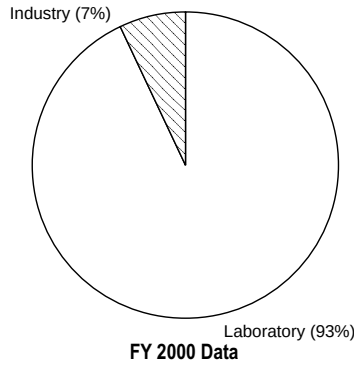
B&R Code: VM30

- Develop, fabricate and supply non destructive assay equipment for HEU transparency monitoring activities in four Russian uranium processing facilities.
- Develop fixed blend-down monitoringy systems for installation in pipes in Russian HEU to LEU down-blending facilities.
- Provide technical expertise as members of HEU monitoring teams to assess Russian facility compliance with non proliferation objectives

Funding History

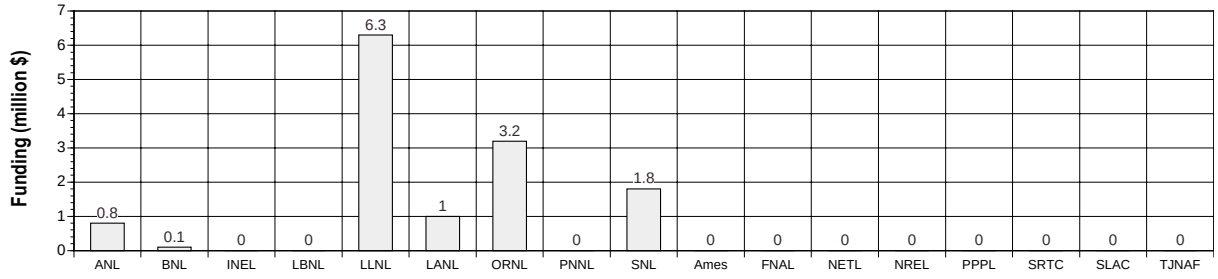


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Preventing Proliferation

Activity: International Emergency Cooperation

DOE Programs

Program: Defense Nuclear Nonproliferation (NN)
Office: Office of International Material Protection and Emergency Cooperation (NN-50)

DOE Laboratory Performers

Principal Laboratories: LANL
Contributing Laboratories: PNNL, RSL
Participating Laboratories: LANL, ORNL

Strategic Goals and Objectives

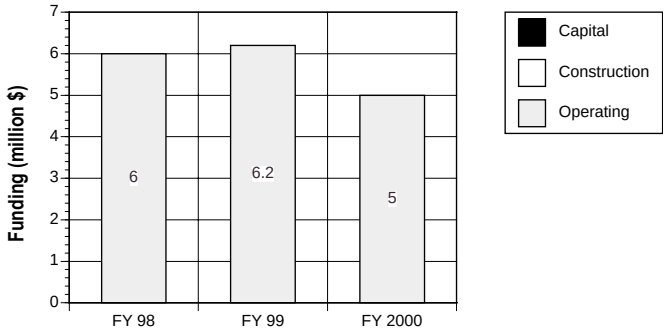
- Support the national security through integration of emergency programs in the international arena and assess the credibility of nuclear threats and smuggling activities.
- Enhance effectiveness of international emergency management systems to promote effective and consistent emergency capabilities commensurate with hazards for the protection of workers, the public, and the environment.
- Assess the credibility of nuclear threats received worldwide.
- Provide rapid assessment and database tracking of nuclear material smuggling activities to include obtaining samples for forensic analysis and traceability.

Activities

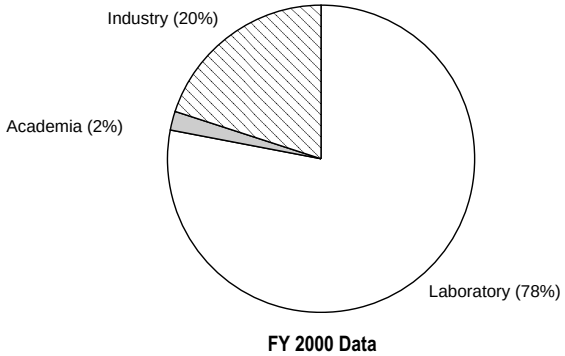
B&R Code: ND0202000

- Support international activities to ensure effective early warning and notification systems.
- Provide technical advice and assistance to international organizations and foreign governments for a cost effective emergency program. Current partners include countries of Russia, Ukraine, France, Germany, Japan, NIS; and organizations of International Atomic Energy Agency, Nuclear Energy Agency, European Union, and Arctic Council.
- Enhance worldwide plume modeling and dispersion compatibility
- Enhance networking of emergency facilities to ensure rapid emergency communications and response
- Conduct Nuclear Forensic Program for material analyses of seized material.

Funding History

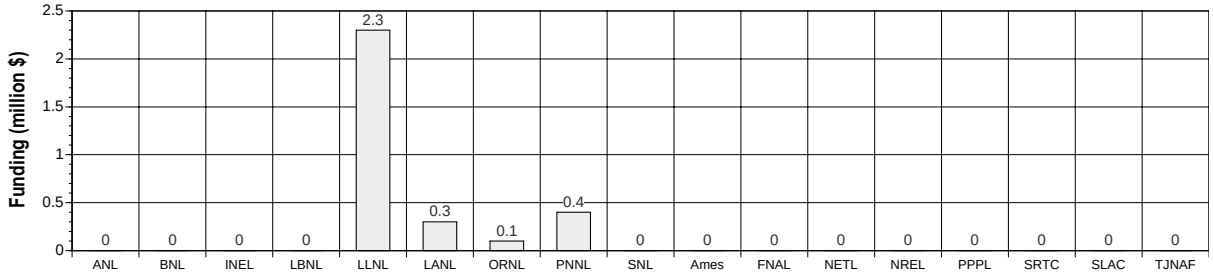


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Monitoring Nuclear Treaties and Agreements

R&D Activity: Nuclear Nonproliferation and Arms Reduction Monitoring

DOE Programs

Program: Defense Nuclear Nonproliferation (NN)
Office: Office of Nonproliferation Research and Engineering (NN-20)

DOE Laboratory Performers

Principal Laboratories: INEEL, LANL, PNNL, SNL
Contributing Laboratories: None
Participating Laboratories: None

Strategic Goals and Objectives

Develop and demonstrate technologies to support current and future nuclear arms control and reduction treaties and agreements. Emphasis is on technologies to monitor nuclear warhead dismantlement and storage of nuclear weapon components and materials. Specific focus is on technologies to:

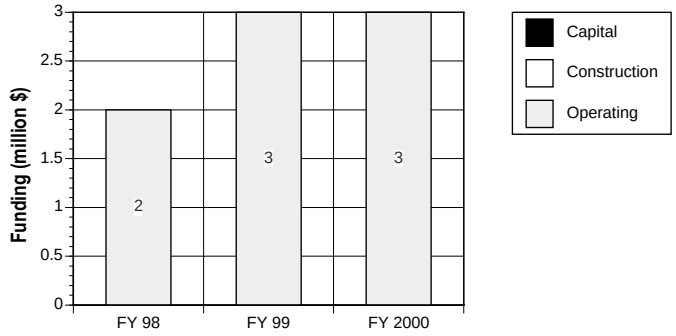
- Confirm that an object being examined is a nuclear weapon or is a weapon component
- Prevent the release of any nuclear weapon design information during monitoring.

R&D Activities

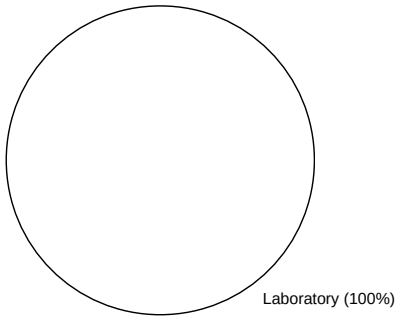
Technologies to enable strategic arms reduction(B&R: GC0401000, GC0404000):

- Develop measurement and signal processing systems that increase the level of confidence that a declared item is a nuclear weapon
- Develop information barriers that protect sensitive weapon design information during dismantlement operations
- Develop tracking and long-term monitoring technologies for stored weapons components

Funding History

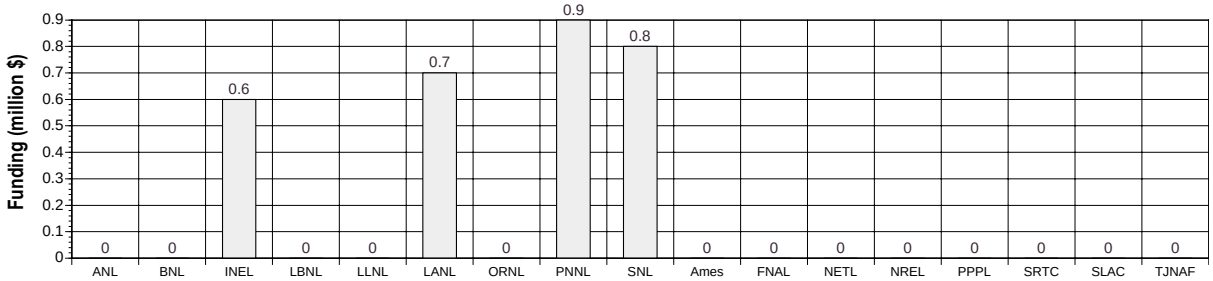


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Preventing Proliferation

R&D Activity: Fissile Materials Disposition – U.S. Program

DOE Programs

Program: Fissile Materials Disposition

Office: NN-61 Office of Reactors
NN-62 Office of Materials and Immobilization
NN-63 Office of Program Integration

DOE Laboratory Performers

Principal Laboratories: LANL, LLNL
Contributing Laboratories: None
Participating Laboratories: ANL, INEEL, ORNL, PNNL, NETL, SNL

Strategic Goals and Objectives

Reduce inventories of U.S. and Russian surplus weapons fissile materials in a transparent and irreversible manner--Implement the U.S. hybrid strategy for plutonium disposition in rough parallel with plutonium disposition in Russia, which include the design, construction , and operation of three disposition facilities

R&D Activities

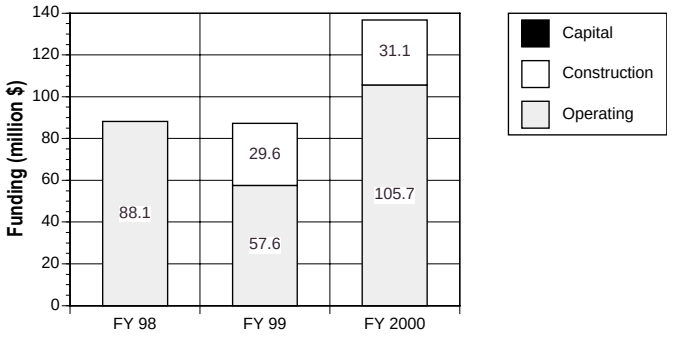
Eliminate surplus U.S. Plutonium within approximately 20 years by irradiating it as mixed oxide fuel and converting some of the materials to an immobilized form. Demonstrate technology to convert pits to plutonium oxide [B&R Code: GA0101010]. Demonstrate technology to immobilizde plutonium oxide [B&R Code: GA0101020]. Demonstrate lead test assembly for irradiation [B&R Code: GA010103 0]. Analyze acceptance of irradiated and immobilized plutonium products in a geological repository [B&R Code: GA0101040]. Store surplus plutonium in a safe and secure manner pending disposition [B&R Code: GA0103013]. Analyze commonalities among disposition paths [B&R Code: GA0103030].

Implement the U.S. hybrid strategy for plutonium dispostion in rough parallel with plutonium dispostion in Russia, which include the design, construction, and operation of three dispostion facilties. Design a pit disassembly and conversion facility to convert surplus weapons plutonium to an unclassified oxide form for disposition and international inspection [B&R Code: 39GA10000]. Design a MOX fuel fabrication facility to convert oxide material into MOX fuel; and irradiate the MOX fuel in existing, domestic, commercial reactors [B&R Code: 39GA30000].

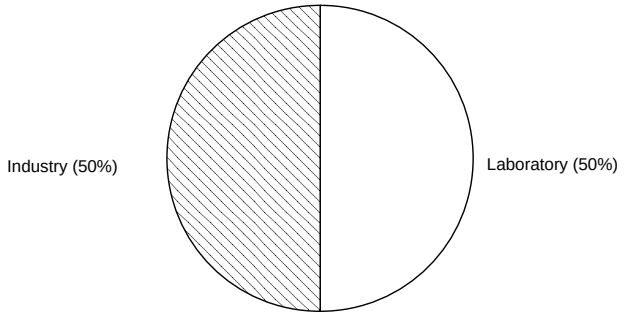
Eliminate surplus U.S. HEU within approximately 20 years primarily by down-blending the material to LEU for peaceful use as fuel for commerdial reactors. Develop conceptual design for blending HEU to LEU and shipping LEU from SRS to commercial vendor [B&R Code: GA0102010].

Eliminate surplus weapons-usable fissile materials. Develop reasonable alternatives for the disposition of U233 [B&R Code: GA0102020]. Analyze environmental impact of disposition of U233 [B&R Code: GA0103020]

Funding History

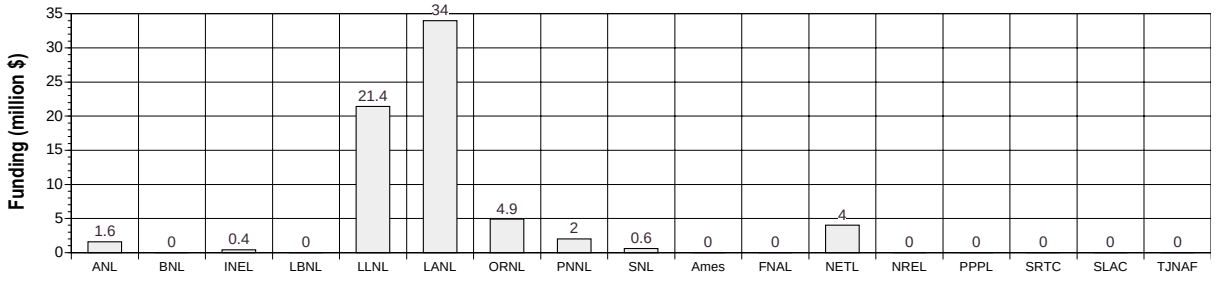


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Preventing Proliferation

R&D Activity: Fissile Materials Disposition – Russian Program

DOE Programs

Program: Fissile Materials Disposition

Office: Office of Program Integration (NN-63)
Office of International Technology and Projects (NN-64)
Office of International Policy (NN-65)

DOE Laboratory Performers

Principal Laboratories: LLNL, ORNL
Contributing Laboratories: None
Participating Laboratories: LANL, PNNL, SNL, NETL

Strategic Goals and Objectives

Reduce inventories of U.S. and Russian surplus weapons fissile materials in a transparent and irreversible manner--Implement a bilateral agreement with Russia to eliminate quantities of surplus Russian plutonium in a rough parallel to U.S. reductions.

R&D Activities

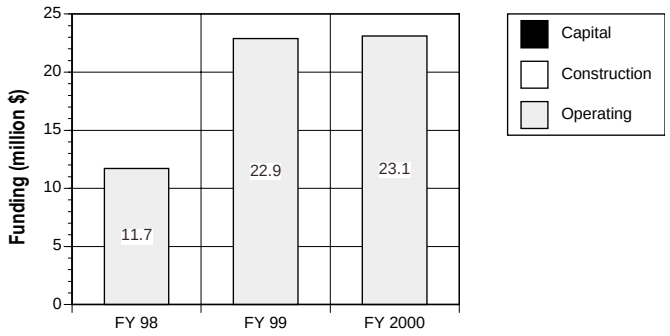
Cooperate with Russia in conducting test and demonstrations of plutonium disposition technologies:
- Demonstrate plutonium conversion [B&R Code: GA0303011]
- Demonstrate use of VVER 1000 reactors [B&R Code: GA0303013]
- Demonstrate use of BN 600 Reactor [B&R Code: GA0303014]
- Demonstrate immobilization technology [B&R Code: GA0303015]
- Demonstrate use of CANDU technology [B&R Code: GA0303017]

Develop advanced reactor technology:
- Develop GTMHR in Russia [B&R Code: GA0302010]
- Support GTMHR Russian activity in U.S. [B&R Code: GA0302020]

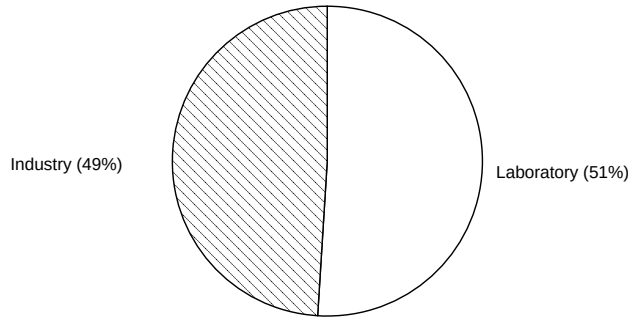
Participate in U.S. government efforts to implement the provision of the bilateral agreement with Russia for the disposition of surplus weapons plutonium [B&R Code:GA0303021]

Assist in U.S. efforts to secure international financing to support plutonium disposition in Russia [B&R Code: GA303016]

Funding History

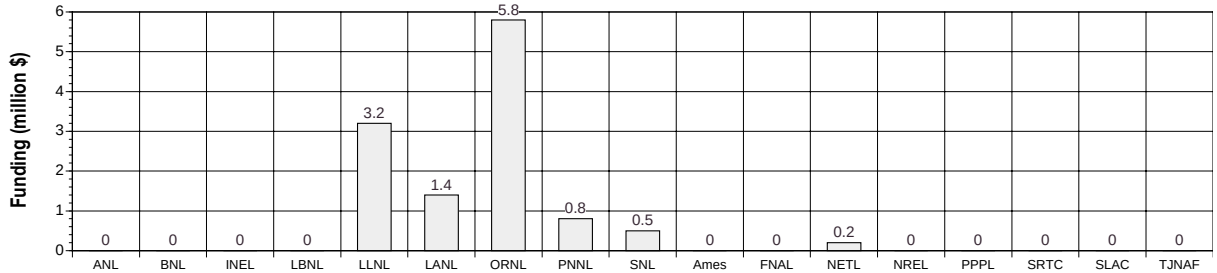


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Preventing Proliferation**

Program Area: Nuclear Material Protection

R&D Activity: Technology Development Program – Physical Security

DOE Programs

Program: Office of Security and Emergency Management
Office: Office of Security Affairs, Office of Safeguards and Security

DOE Laboratory Performers

Principal Laboratories: SNL, LLNL
Contributing Laboratories: None
Participating Laboratories: ORNL

Strategic Goals and Objectives

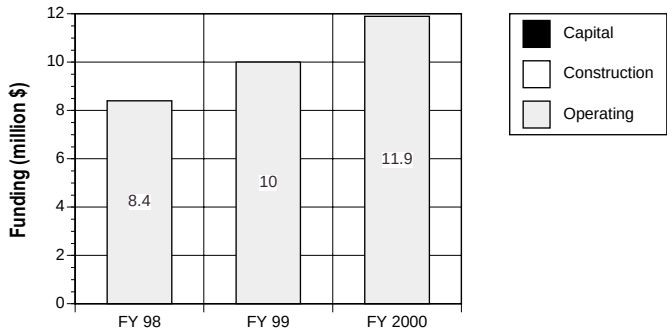
- Ensure the vitality of DOE's national security enterprise.
- Protecting nuclear materials, facilities, and information.

R&D Activities

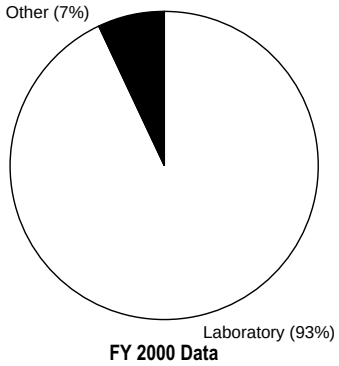
- Protecting nuclear materials, facilities and Information
- Develop advanced technologies in access delay, intrustion detection, biometrics, entry control, video assessments, and chemical/biological agent detection.

GD060401
GD060501
GD060601

Funding History

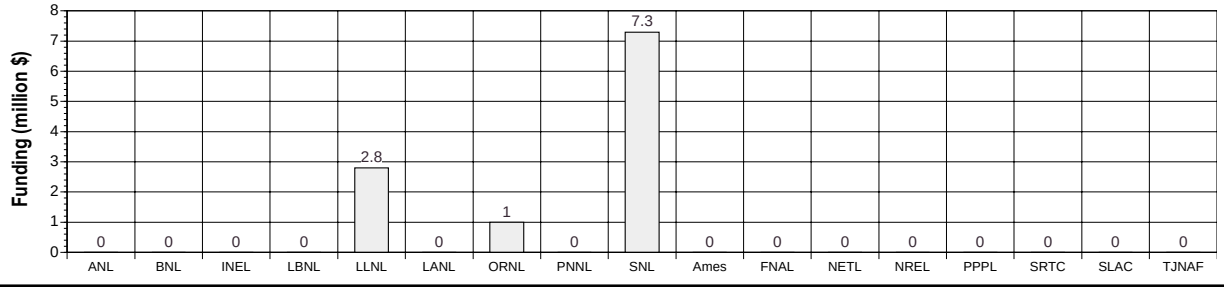


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Preventing Proliferation**

Program Area: Nuclear Material Protection

R&D Activity: Technology Development Program – Information Security

DOE Programs

Program: Office of Security and Emergency Management
Office: Office of Security Affairs, Office of Safeguards and Security

DOE Laboratory Performers

Principal Laboratories: LANL, LLNL
Contributing Laboratories: None
Participating Laboratories: PNNL, SNL, ORNL

Strategic Goals and Objectives

- Ensure the vitality of DOE's national security enterprise.
- Protecting nuclear materials, facilities, and information.

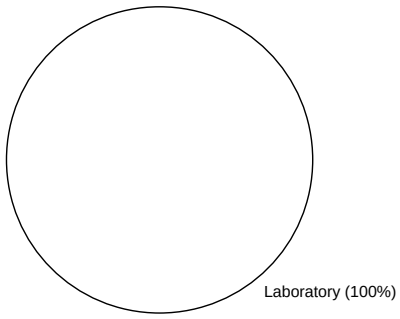
R&D Activities

- Protecting nuclear materials, facilities and Information
- Develop advanced technologies in automated information intrusion detection and response capabilities.

GD060403
GD060503
GD060603

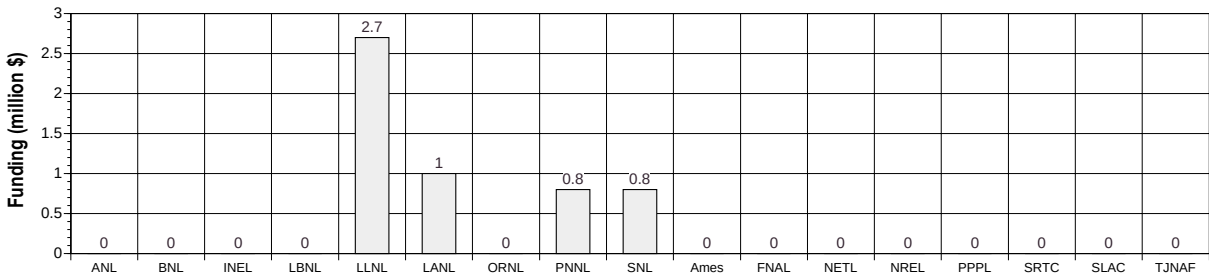
Funding History

Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Preventing Proliferation**

Program Area: Nuclear Material Protection

R&D Activity: Technology Development Program

DOE Programs

Program: Material Control
Office: Office of Security and Emergency Management
Office of Security Affairs, Office of Safeguards and Security

DOE Laboratory Performers

Principal Laboratories: LANL, LLNL
Contributing Laboratories: None
Participating Laboratories: ANL, PNNL, ORNL, SNL, INEEL

Strategic Goals and Objectives

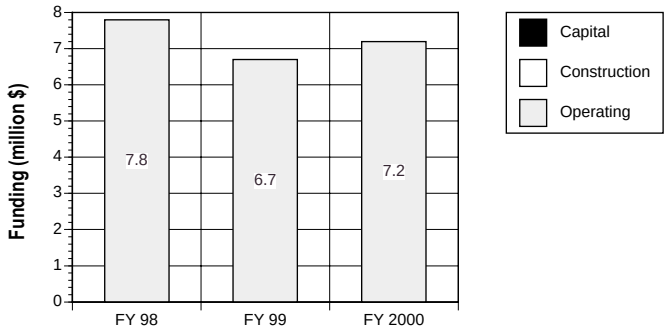
- Ensure the vitality of DOE's national security enterprise.
- Protecting nuclear materials, facilities, and information.

R&D Activities

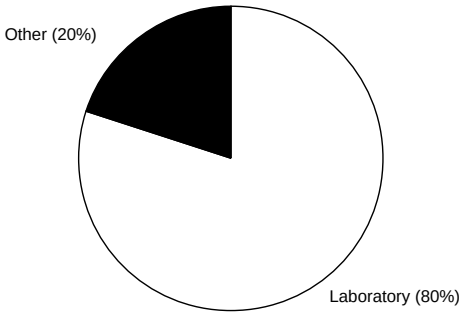
- Protecting nuclear materials, facilities and Information
- Develop advanced technologies in the measurement, control, and accountability of special nuclear materials.

GD060402
GD060502
GD060602

Funding History

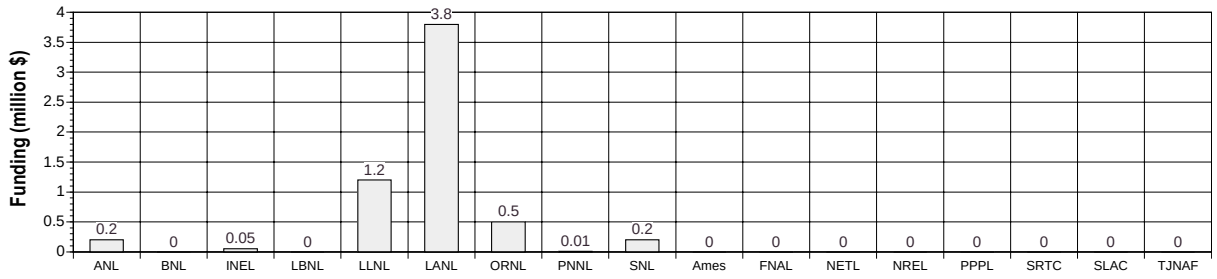


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Preventing Proliferation**

Program Area: Nuclear Material Protection

R&D Activity: Technology Development Program

DOE Programs

Program: Information Security
Office: Office of Security and Emergency Management
Office of Security Affairs, Office of Safeguards and Security

DOE Laboratory Performers

Principal Laboratories: LLNL, LANL
Contributing Laboratories: PNNL
Participating Laboratories: SNL

Strategic Goals and Objectives

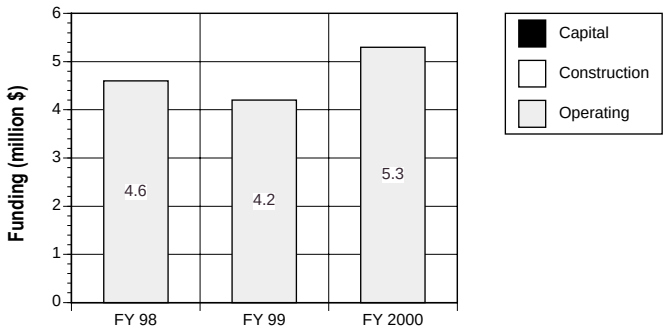
- Ensure the vitality of DOE's national security enterprise.
- Protecting nuclear materials, facilities, and information.

R&D Activities

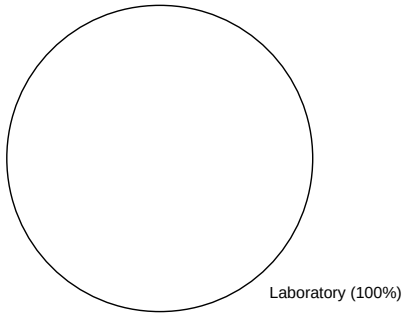
- Protecting nuclear materials, facilities and Information
- Develop advanced technologies in automated information intrusion detection and response capabilities.

GD060403
GD060503
GD060603

Funding History

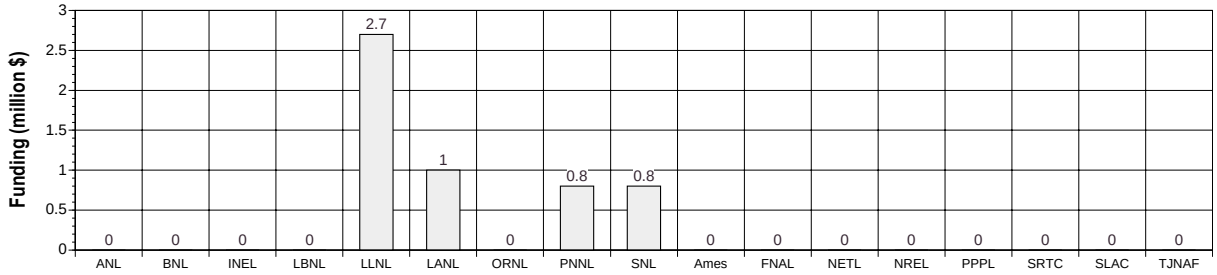


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Preventing Proliferation**

Program Area: Nuclear Material Protection

R&D Activity: Technology Development Program – Material Control and Accounting

DOE Programs

Program: Office of Security and Emergency Management
Office: Office of Security Affairs, Office of Safeguards and Security

DOE Laboratory Performers

Principal Laboratories: LANL, LLNL
Contributing Laboratories: None
Participating Laboratories: ANL, PNNL, SNL

Strategic Goals and Objectives

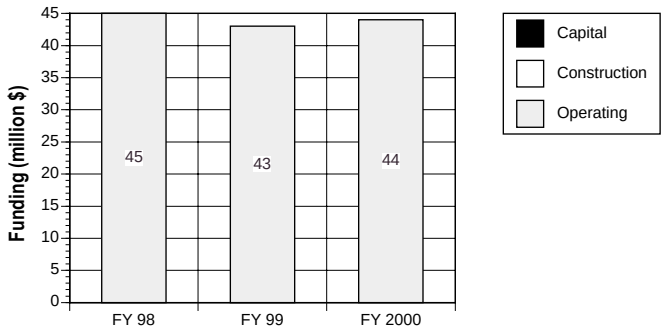
- Ensure the vitality of DOE's national security enterprise.
- Protecting nuclear materials, facilities, and information.

R&D Activities

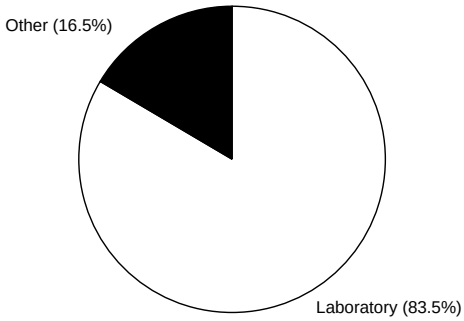
- Protecting nuclear materials, facilities and Information
- Develop advanced technologies in the measurement, control, and accountability of special nuclear materials.

GD060402
GD060502
GD060602

Funding History

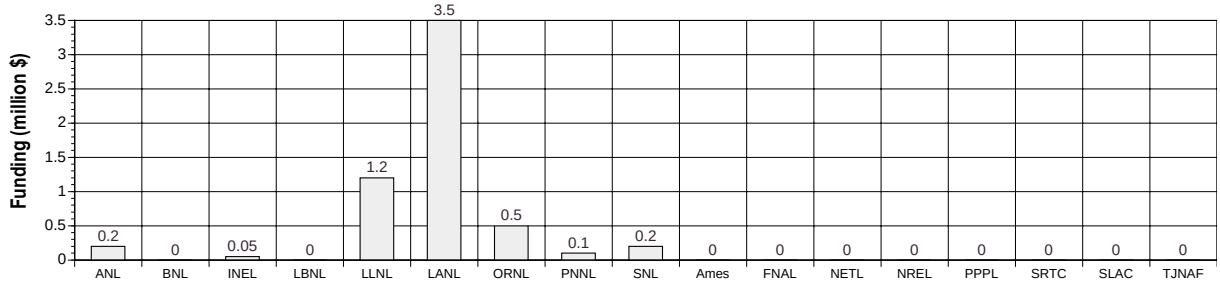


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Preventing Proliferation

Activity: Arms Control and Nonproliferation

DOE Programs

Program: Defense Nuclear Nonproliferation (NN)
Office: Office of Arms Control and Nonproliferation (NN-40)

DOE Laboratory Performers

Principal Laboratories: None
Contributing Laboratories: ANL, LANL, LLNL, SNL, PNNL
Participating Laboratories: BNL, INEEL, LBNL, NREL, ORNL, SRTC

Strategic Goals and Objectives

Reduce the threat of nuclear proliferation by integrating and orchestrating the Department's assets and efforts, including those of its national laboratories and contractors, by providing major policy and technical support to the U.S. Government's foreign policy and national security objectives in the areas of arms control and nonproliferation, and to the international arms control and nonproliferation community. The Department provides policy and technical leadership for national and global nonproliferation efforts to reduce the continuing and new global nuclear dangers. Specific focus is on Securing Nuclear Materials and Expertise in Russia, the Newly Independent States (NIS), and the Baltics; Limiting Weapons-Usable Fissile Materials; Promoting Transparent and Irreversible Nuclear Reductions; Strengthening the Nuclear Nonproliferation Regime; and Controlling Nuclear Exports.

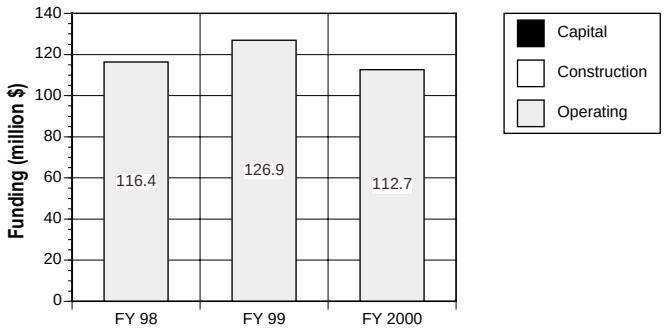
Activities

[B&R Codes: GJ1200000, GJ1100000, GJ0400000, GJ0100000, GJ0200000, GJ0902000, GJ0904000, GJ0901000, GJ0903000]

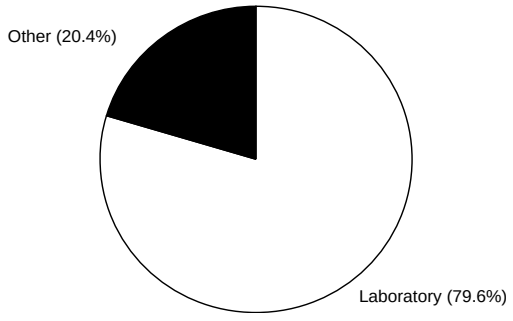
The role of the laboratories is to provide support for:

- MPC&A Activities in the Baltics and NIS
- Reduced Enrichment Research and Test Reactors program
- Policy and Analysis
- Initiatives for Proliferation Prevention
- Nuclear Cities Initiative
- International Safeguards
- Treaties and Agreements
- International Security

Funding History

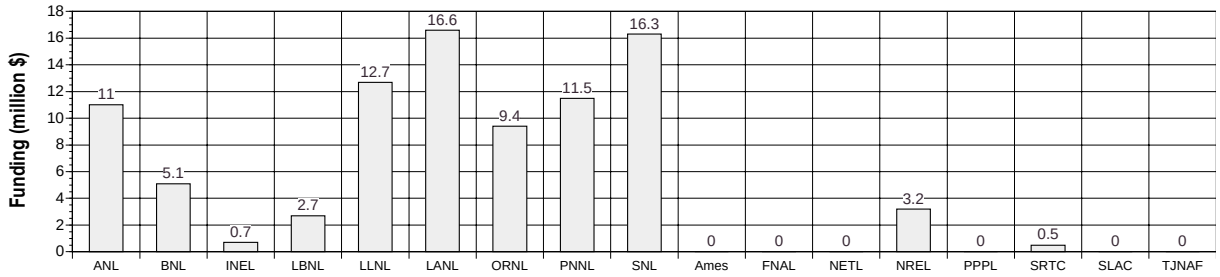


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Detecting Proliferation

R&D Activity: Sensor/System Development

DOE Programs

Program: Office of Defense Nuclear Nonproliferation (NN)
Office: Office of Nonproliferation Research and Engineering (NN-20)

DOE Laboratory Performers

Principal Laboratories: LANL, LLNL, SNL
Contributing Laboratories: None
Participating Laboratories: INEEL, PNNL, SRTC

Strategic Goals and Objectives

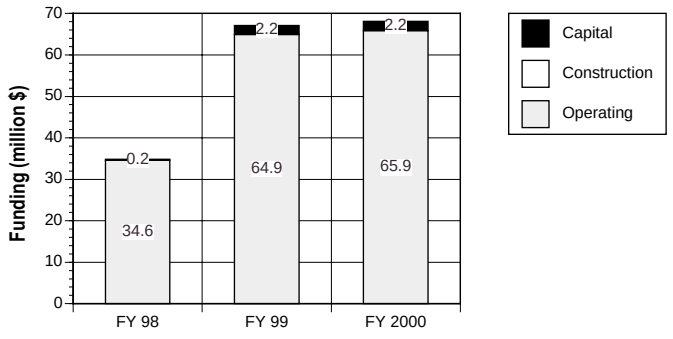
- Reduce the global danger from the proliferation of weapons of mass destruction (WMD) by developing and demonstrating the potential utility of innovative sensing concepts, sensors and systems for the early detection of proliferation activities.

R&D Activities

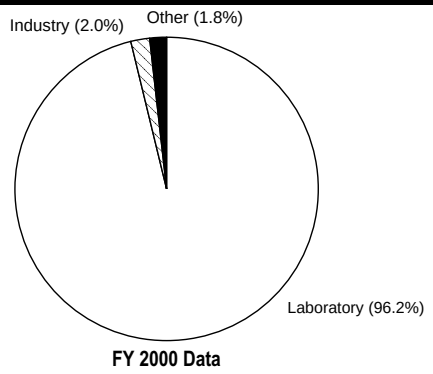
Sensor/System Development (B&R: GC0403000, GC0404000, GC0401000)

- Examine the nature of proliferation activities to identify and characterize observable signatures.
- Develop innovative sensor system concepts and hardware to examine these signatures.
- Conduct experiments and phenomenological modeling to understand the environment's effects on observables and how these effects can be taken into account.
- Develop techniques to interpret the data and produce meaningful information.
- Perform experiments to demonstrate the potential utility of innovative proliferation detection technologies and advanced data analysis.
- Establish U.S government technology partnerships to transfer successful technology to users.

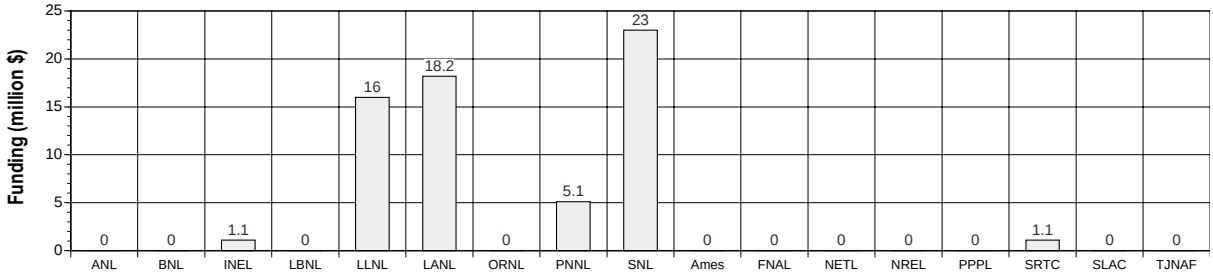
Funding History



Laboratory-Academia-Industry Participation



Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Countering Weapons of Mass Destruction Terrorism

R&D Activity: Nuclear

DOE Programs

Program: Defense Nuclear Nonproliferation (NN)
Office: Office of Nonproliferation Research and Engineering (NN-20)

DOE Laboratory Performers

Principal Laboratories: LLNL
Contributing Laboratories: LANL, ORNL, PNNL, SNL
Participating Laboratories: Ames, ANL, BNL, LBNL, SRTC

Strategic Goals and Objectives

Develop and demonstrate technologies for counter nuclear smuggling and enhancing law enforcement forensics. The technology development activities supported under this area are broadly aimed at the development of enabling technologies to inhibit nuclear materials diversion in nonproliferation, arms reduction, and counter terrorism applications. Specific focus is on technologies to:

- Detect and attribute the presence of nuclear materials
- Analyze materials, including support to law enforcement
- Warn of nuclear materials in transit

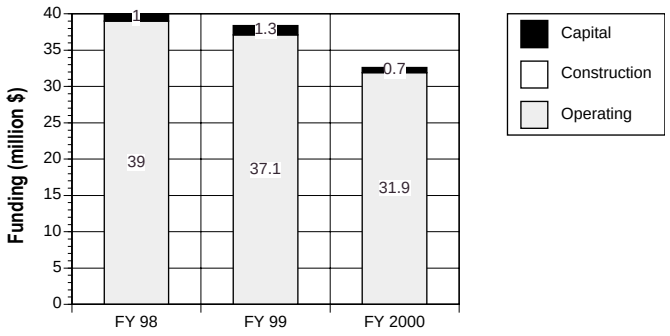
R&D Activities

Detect and Attribute Nuclear Materials (B&R: GC0401000, GC0404000)
- Develop systems of detectors to cover large areas
- Develop materials and signal processing for next generation detectors

Materials Analysis (B&R: GC0401000, GC0404000)
- Selection of useful signatures
- Development of improved sampling methods
- Development of new analytical instruments and improved procedures
- Evaluation of analysis technologies

Warning of Nuclear Materials in Transit (B&R: GC0401000, GC0404000)
- Develop remote means to measure bulk amounts of Pu and HEU
- Develop measurement systems to distinguish warheads and their components

Funding History



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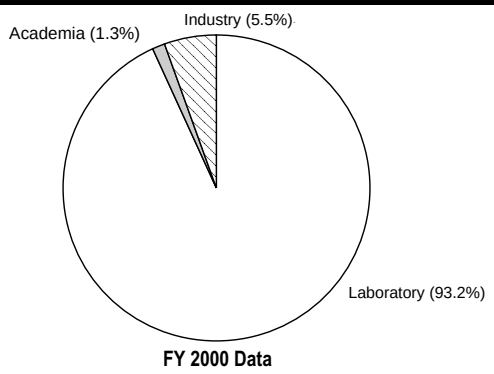

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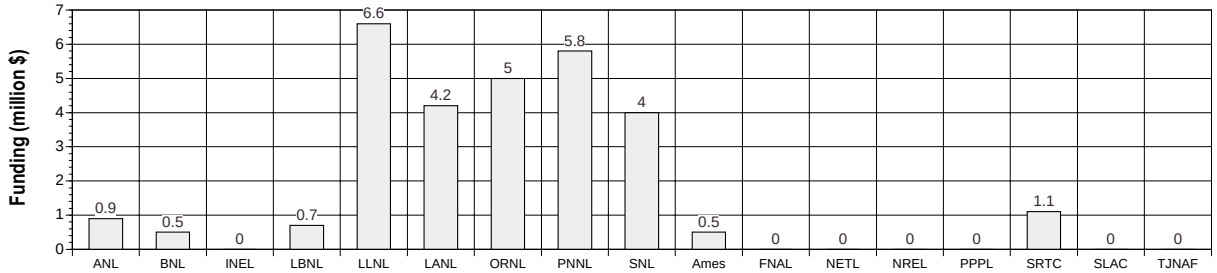


National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Countering Weapons of Mass Destruction Terrorism

R&D Activity: Chemical and Biological National Security Program (CBNP)

DOE Programs

Program: Defense Nuclear Nonproliferation (NN)
Office: Office of Nonproliferation Research and Engineering (NN-20)

DOE Laboratory Performers

Principal Laboratories: LANL, LLNL
Contributing Laboratories: SNL
Participating Laboratories: ANL, BNL, LBNL, ORNL, PNNL

Strategic Goals and Objectives

Chemical and Biological National Security Program (CBNP) Mission: Develop, demonstrate, and deliver technologies and systems that will lead to major improvements in the U.S. capability to prepare for and respond to chemical or biological attacks.

R&D Activities

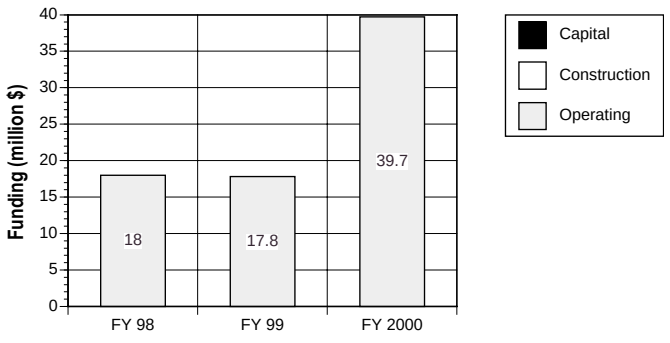
Technology Development Iniatives (B&R: GC0404000, GC0401000)

- Chemical and Biological Detection: Develop a suite of detection systems that will significantly improve chemical and biological detection capabilities in urban environments for Federal, state and local responders.
- Modeling and Prediction: Develop tools for accurate prediction of chemical and biological agent dispersal in urban release scenarios.
- Decontamination and Restoration: Develop rapid, effective, and safe (non-toxic and non-corrosive) decontamination technologies for a range of chemically and biologically contaminated surfaces.
- Biological Foundations: Develop molecular biology based capabilities to support efforts in advanced detection, attribution, and medical countermeasures.

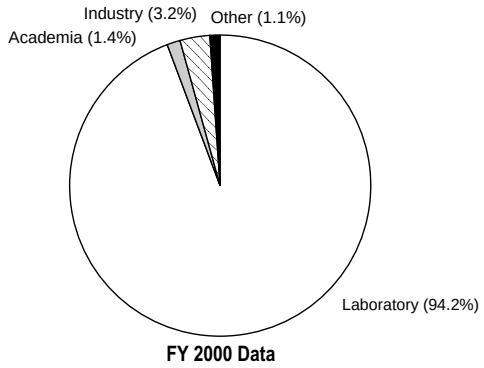
Domestic Demonstration and Application Programs (B&R: GC0404000, GC0401000)

- PROTECT—Program for Response Options and Technology Enhancements for Chem/Bio Terrorism, Goal is to develop and demonstrate technologies and analysis tools to support protection of "at risk" facilities (e.g. subways, airports and major buildings) against chemical agents.
- BASIS—Biological Aerosol Sentry and Information System. Goal is to field a portable biological agent monitoring system for protecting special events or for deployment to a major city during high alert conditions.

Funding History



Laboratory-Academia-Industry Participation



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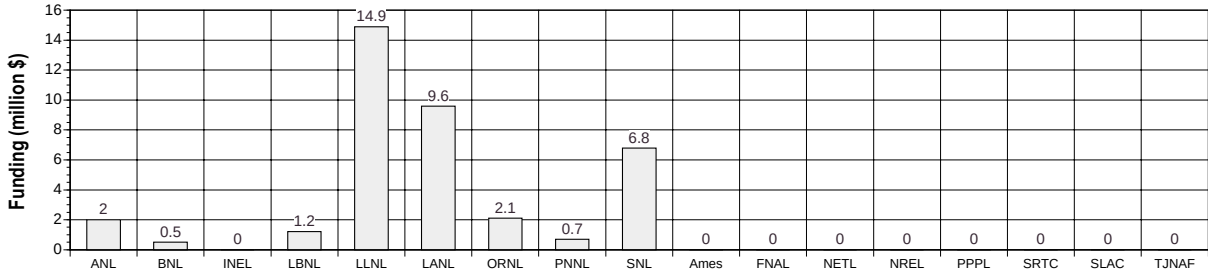


National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Promoting International Nuclear Safety and Cooperation

Activity: International Nuclear Safety

DOE Programs

Program: Defense Nuclear Nonproliferation (NN)
Office: Office of International Nuclear Safety and Cooperation (NN-30)

DOE Laboratory Performers

Principal Laboratories: PNNL
Contributing Laboratories: None
Participating Laboratories: ANL

Strategic Goals and Objectives

- Reduce national security and nonproliferation risks associated with foreign nuclear power plants and nuclear facilities, especially those in the former Soviet Union.
- Objectives include:

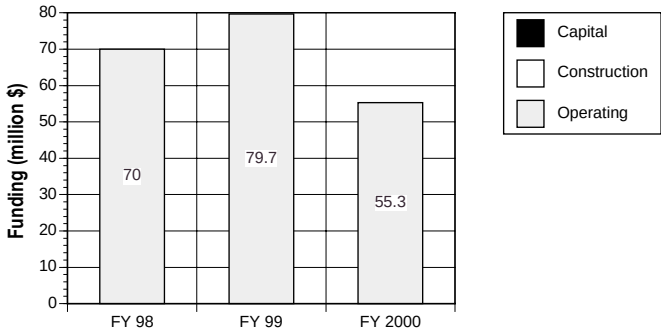
  (1) improving the safety of Soviet-designed nuclear power plants and shutting down most hazardous of those facilities; (2) assisting host countries to develop and implement self-sustaining nuclear safety infrastructure and improvement programs capable of implementing internationally accepted safety practices, and; (3) developing and deploying proliferation resistant nuclear technologies.

Activities

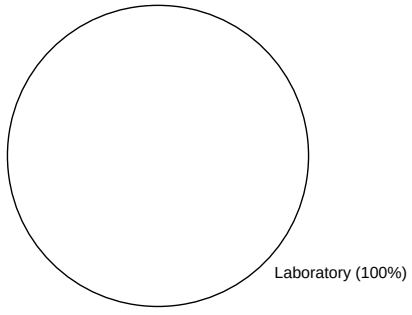
[B&R Code: VM15]

- Provide Ukraine with non-destructive examination and safety maintenance technologies and training.
- Provide Russia with intergranular stress corrosion cracking technologies.
- Develop safety parameter display systems.
- Conduct safety analyses and incorporate methodologies for application in nuclear power plants.
- Construct a replacement heat plant to generate heat for decommissioning facilities in Chornobyl.
- Provide decommissioning planning for the Chernobyl site.
- Provide full-scale simulators to improve operator training at several nuclear power plants in Russia and Ukraine.

Funding History

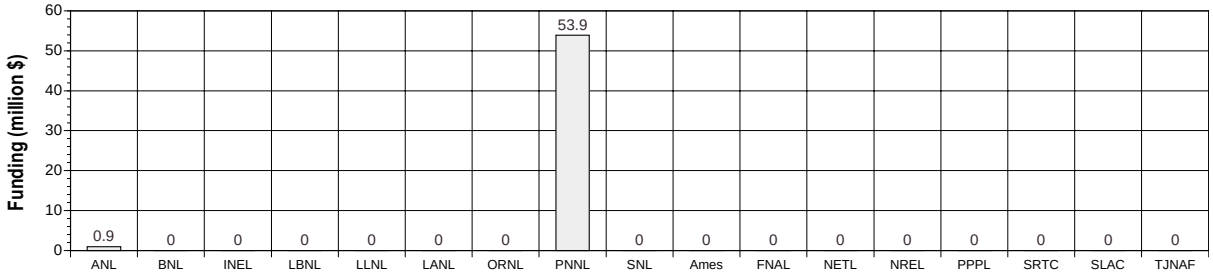


Laboratory-Academia-Industry Participation



FY 2000 Data

Fiscal Year 2000 Funding Profile



National Security | **Strategic Goal: Reduce the Global Danger from Proliferation of WMD**

Program Area: Preventing Proliferation

Activity: International Materials Protection, Control, and Accounting

DOE Programs

Program: Defense Nuclear Nonproliferation (NN)
Office: Office of International Material Protection and Emergency Cooperation (NN-50)

DOE Laboratory Performers

Principal Laboratories: SNL
Contributing Laboratories: BNL, LLNL, ORNL
Participating Laboratories: ANL, INEEL, LANL, PNNL

Strategic Goals and Objectives

Place all 960 metric tons of Russian HEU and Plutonium under rapid and comprehensive Materials Protection, Control, and Accounting (MPC&A) upgrades by 2011.

- Rapid upgrades have been initiated for 73 metric tons and should be completed for all 960 metric tons by 2005.
- Rapid upgrades have been completed for 342 metric tons and should be completed for all 960 metric tons by 2006.
- Comprehensive upgrades have been completed for 137 metric tons and should be completed for all 960 metric tons by 2011.

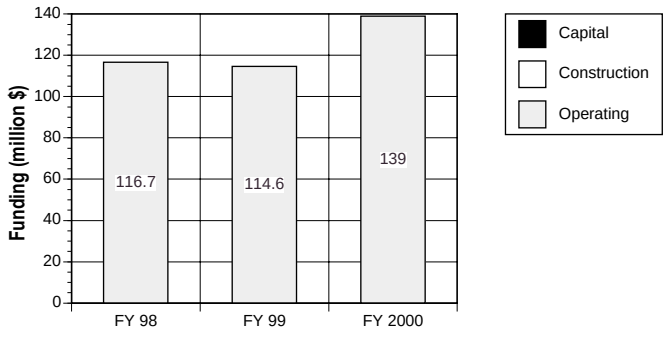
Activities

[B&R Code: GJ0800000]

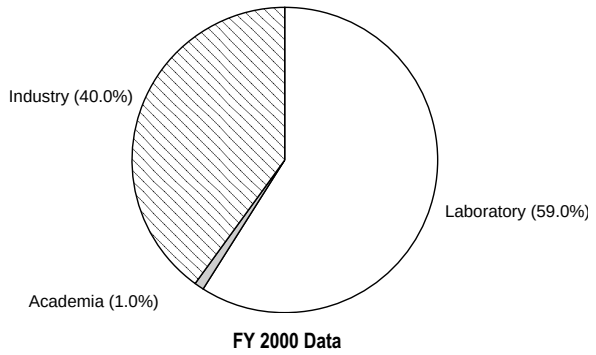
- Provide technical support to Russia to improve security on nuclear material.

It should be noted, in reference to the Laboratory-Academia-Industry Participation chart below, that all Materials Protection, Control, and Accounting (MPC&A) funds go to the National Laboratories first. Of these funds, the laboratories spend 41 percent on their labor and travel to oversee contracts and to provide the technical support and training required to implement MPC&A upgrades. The remaining 59 percent is sent via laboratory contracts to Russian sites, equipment vendors, and technical institutes that design and install MPC&A upgrades, support national training centers, and contribute to the development of Russian MPC&A regulations, oversight, and measurement standards.

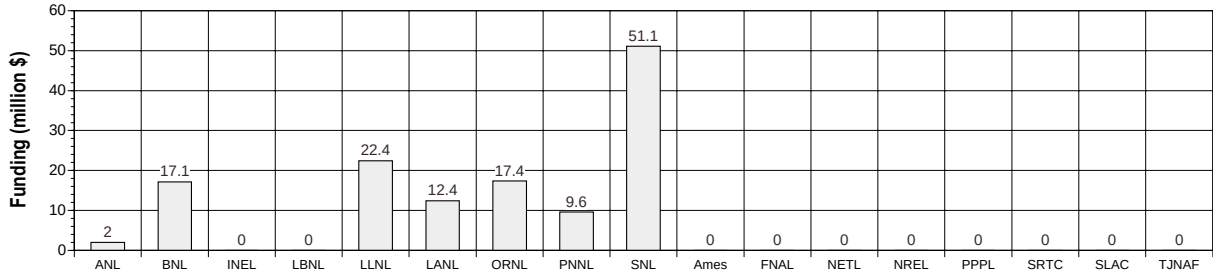
Funding History



Laboratory-Academia-Industry Participation



Fiscal Year 2000 Funding Profile



Science | **Strategic Goal: Fuel the Future**

Program Area: New Fuels

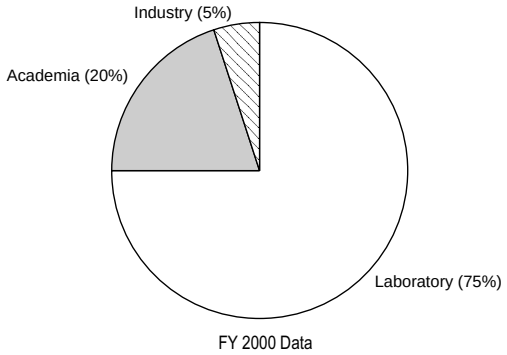
R&D Activity: Solar Energy Conservation, Plant and Microbial Research, Geosciences, and Materials Chemistry

DOE Programs

Program: Science

Office: Basic Energy Science
Biological and Environmental Research

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- To provide the leadership, foundations, and breakthroughs in the physical sciences that will sustain advancements in our Nation's quest for clean, affordable and abundant energy.
- To understand the geological, chemical, biological, and physical processes for clean and affordable domestic fuels.

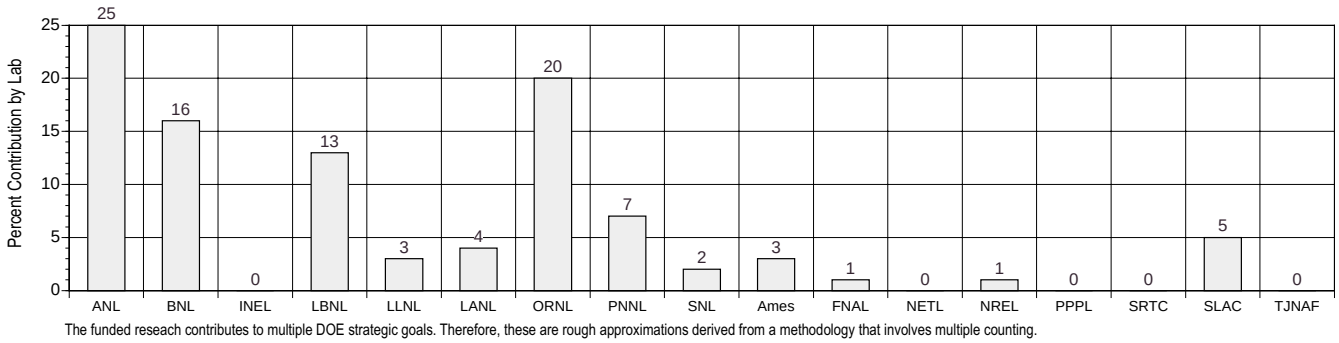
R&D Activities

Solar Energy Conversion: Basic research in photochemical energy conversion ranges from the photophysics associated with direct conversion of solar energy to electricity to the photochemical conversion of solar radiation to fuels and specialty chemicals. Related to the photochemistry program but using different techniques is the radiation chemistry research program. A major goal is to obtain molecular level information on chemical reactivity in solution, reactive transient intermediates, the kinetics and mechanisms of chemical reactions and processes at the solid/liquid interface. This research is conducted at national laboratories and universities.

Plant and Microbial Research: Mechanistic research on fundamental biological processes related to capture, transformation, storage, and utilization of energy. Research focuses on the microbiologically driven carbon exchange between the oceans and atmosphere and the exchange between the atmosphere and the terrestrial biosphere and soils. These exchanges have been absorbing much of the anthropogenic carbon released to the atmosphere. Genomic DNA sequences will be determined for microbes capable of transforming sunlight and waste products, including cellulose, into energy, such as methane and hydrogen, at room temperature and room pressure, offering the promise of new energy sources. This research is conducted primarily at universities. A Memorandum of Understanding signed in 1987 established a three-agency plant science partnership (DOE, NSF, and USDA) that jointly solicits and reviews proposals for multi-institutional research coordinating group awards and interdisciplinary research training group awards. In addition, there is an internationally recognized group at the Plant Research Laboratory at Michigan State University, which studies many areas of plant science and uses Arabidopsis as a model plant system. The Complex Carbohydrate Research Center at the University of Georgia provides services and instrumentation for the structural analysis of carbohydrates derived from microbial sources.

[Continued on page 2]

Fiscal Year 2000 Funding Profile



The funded reseach contributes to multiple DOE strategic goals. Therefore, these are rough approximations derived from a methodology that involves multiple counting.

R&D Activity: Solar Energy Conservation, Plant and Microbial Research, Geosciences, and Materials Chemistry

R&D Activities (continued)

Geosciences: Research aimed at building the long-term fundamental knowledge base underlying energy technologies of the future. These future energy technologies will involve exploration, enrichment, production, conversion and consumption of energy and mineral resources and generation of technological wastes. Energy and mineral utilization will also require a better understanding of natural processes that will help to minimize anthropogenic perturbations of earth systems. Ultimately, geosciences research impacts control of industrial processes to improve efficiency and reduce pollution, to increase energy supplies, and to lower cost and increase the effectiveness of environmental remediation at polluted sites. Advances in geophysical imaging are improving the basis for characterizing the distributions of material properties, including layering, mineralogy, lithology, geometry, fracture density, porosity, fluid distribution and type, and composition of the lithosphere. Geophysical methods are achieving higher resolution and greater penetration. This research is conducted at national laboratories, and in industry and universities.

Materials Chemistry: Basic research including the synthesis and characterization of complex, multicomponent materials with improved properties through new combinations of atoms and new degrees of complexity. The program emphasizes biomolecular and organic materials research and the self-assembly of structures on a nanoscale to take advantage of the huge number of biomolecular materials and processes. The aim is a fundamental understanding of the behavior of novel materials and structures. Materials chemistry provides the primary support for fundamental research in surface science, polymers and organic materials, and for new inorganic materials. The surface science is important for energy in the understanding which can bear on catalysis as well as surface interactions which lead to degradation and corrosion of surfaces including photovoltaic devices, batteries and fuel cells. New techniques for fabrication of nanocrystals such as the use of inverse micelles may have a big influence on the development of arrays of tunable photoabsorption materials for conversion of sunlight into stored energy. Similarly, the development of synthetic membranes may have uses for separations and for energy storage. Research on solid electrolytes is already paying off in new rechargeable batteries which can be recharged many more times than existing commercial cells. Research on polymers may lead to lightweight structural materials that can be used for automobiles and thereby provide substantial savings in gas mileage, and reduce corrosion. It should be noted that Saturn cars use polymeric door panels which are flexible and bounce back after deformation. This research is conducted predominantly at national laboratories and universities.

Science | **Strategic Goal: Fuel the Future**

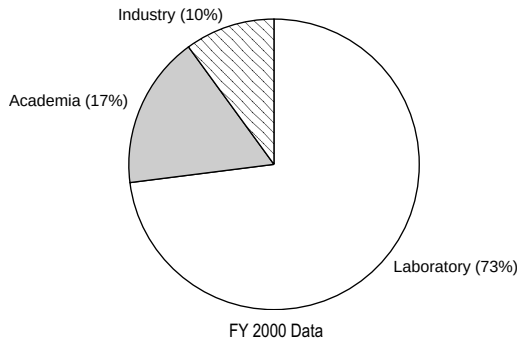
Program Area: Clean and Affordable Power

R&D Activity: Plasma Science and Fusion Research; Condensed Matter Physics; Metal and Ceramic Sciences; and Energy Production, Storage and Transmission

DOE Programs

Program: Science
Office: Basic Energy Science
Fusion Energy Sciences

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- Providing the leadership, foundations, and breakthroughs in the physical sciences that will sustain advancements in our Nation's quest for clean, affordable and abundant energy.
- Understanding the physical, material, and chemical processes for advanced power generation, storage, and transmission.

R&D Activities

Plasma Science and Fusion Research: Basic research to advance plasma science, fusion science and fusion technology, and thereby establish the knowledge base of an economically and environmentally attractive fusion energy source. The three objectives of the program are to understand the science of plasmas, identify and explore innovative and cost-effective development paths to fusion energy, and to explore the science and technology of energy producing plasmas as a partner in an international effort. This research is conducted at universities, national laboratories, and industrial firms.

Condensed Matter Physics: Basic research to gain a fundamental understanding of the behavior of materials. Experimental measurements seek to determine electronic structure, transport properties, phase transitions, mechanism for high temperature superconductivity, complexity in electronic interactions, and self-organization of electronic states. This includes fundamental measurements of the properties of solids, liquids, glasses, surfaces, thin films, artificially structured materials, self-organized structures, and nanoscale structures. This activity also supports basic research in theory and simulations of condensed matter, the use of ion beams to study and modify the properties of materials, and engineering applications. The theory activity complements much of the experimental work by guiding, stimulating, and explaining experiments. It includes the support of selected centers with specific materials-related missions. These centers excel in bringing together individual scientists from widely different backgrounds to work on common research areas or make use of common research tools. Included among these are the Center for X-ray Optics and the Centers for Advanced Materials at Lawrence Berkeley National Laboratory and the Surface Modification and Characterization Facility at Oak Ridge National Laboratory. This research is conducted at national laboratories and universities.

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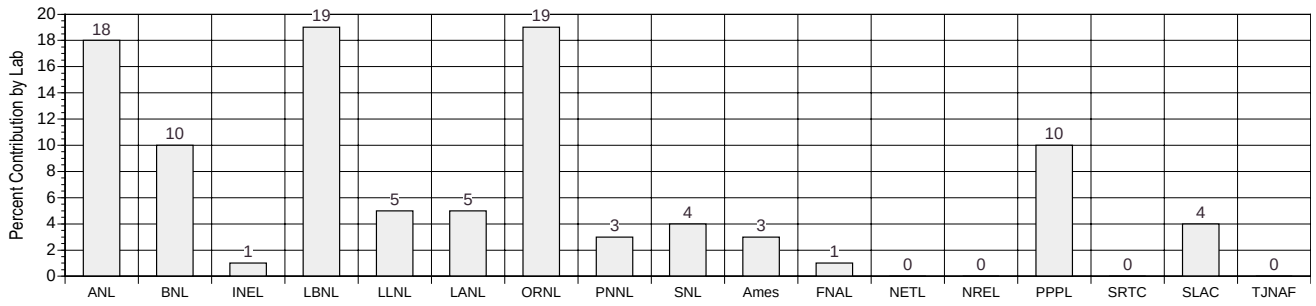
Fiscal Year 2000 Funding Profile



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Science **Strategic Goal: Fuel the Future**

Program Area: Clean and Affordable Power

R&D Activity: Plasma Science and Fusion Research; Condensed Matter Physics; Metal and Ceramic Sciences; and Energy Production, Storage and Transmission

R&D Activities (continued)

Metal and Ceramic Sciences: Fundamental experimental research that specifically targets the needs of the DOE technology programs and, therefore, has significant impacts on energy generation, transmission, conversion, and conservation technologies. The work conducted in this program is long-term fundamental research in materials, with a focus on the influence of synthesis and processing on the materials' structure and properties. Mechanical behavior and radiation damage are also studied to understand the fundamental principles of the defect-property relationship on an atomic level, so that predictive models can be developed that will permit the design of materials that have desired mechanical behavior and resistance to irradiation damage. Linkage -of materials' structure at the atomic level to behavior at the continuum level will become a reality, thus bringing new rigor to the science of mechanical behavior. This research is conducted predominantly at national laboratories and universities.

Energy Production, Storage and Transmission: Basic research addressing the energy aspects of chemically related engineering sciences, including thermodynamics, turbulence related to combustion, and physical and chemical rate processes. Particular attention is given to experimental and theoretical aspects of phase equilibria, especially of mixtures, including supercritical phenomena, and to the physics of gas phase turbulence. Also included are fundamental studies of thermophysical and thermochemical properties. Emphasis is given to improving and/or developing the scientific base for engineering generalizations and their unifying theories. Also included is fundamental research in areas critical to understanding the underlying limitations in the performance of electrochemical energy storage and conversion systems. Areas of research include the characterization of anode, cathode, and electrolyte systems and their interactions. The program covers a broad spectrum of research, including fundamental studies of composite electrode structures, failure and degradation of active electrode materials, and thin film electrodes, electrolytes, and interfaces. The aim is providing knowledge that will lead to improvements in battery size, weight, life, and recharge cycles.

Science | **Strategic Goal: Fuel the Future**

Program Area: Efficient Energy Use

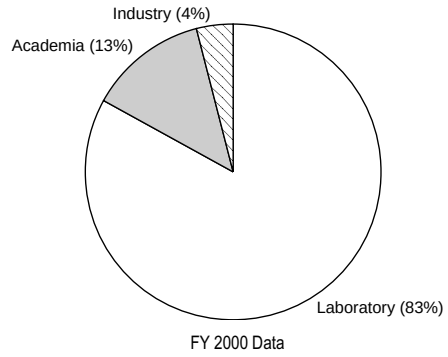
R&D Activity: Combustion-Related Research, Advanced Materials, Engineering Sciences, and Catalysis and Chemical Transformations

DOE Programs

Program: Science

Office: Basic Energy Science
Advanced Scientific Computing Research

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- Providing the leadership, foundations, and breakthroughs in the physical sciences that will sustain advancements in our Nation's quest for clean, affordable and abundant energy.
- To understand the engineering, materials, and chemical processes to develop new energy efficient technologies.

R&D Activities

Combustion-Related Research: Scientific investigations, at the molecular level, of chemical reactions in the gas phase, at surfaces, and at interfaces and the relationship between molecular scale phenomena and bulk phenomena. Research activities involve closely coupled experimental and theoretical efforts. Experimental projects include studies of molecular dynamics, chemical kinetics, spectroscopy, clusters, and surface science. The goal related to energy efficiency is to increase the efficiency of the combustion process. Combustion-related chemical physics research is conducted at several national laboratories (including a single-purpose laboratory devoted to combustion, the Combustion Research Facility (CRF) at Sandia National Laboratory) and at a broad spectrum of universities. Cluster research is carried out at both national laboratories and universities, while work related to the solid-liquid interface and the relationship to environmental remediation issues is performed predominantly at national laboratories.

Advanced Materials: Scientific research in advanced materials concerned with the microstructural aspects of geometrical packing configurations of atoms in solids, defects and imperfections in those packing configurations, and the microscale morphology and composition of crystalline solids. The objective is to develop quantitative models and theories depicting the structure of materials because that structure, in turn, relates to and controls their behavior and performance. Advanced materials research also includes engineering behavior with a focus on the influence of synthesis and processing on materials structure and properties. Physical behavior of materials is concerned with understanding the mechanisms for various forms of physical behavior, particularly under conditions that interact with and change the bulk and/or surface structure of the material. The objective is to predict physical behavior by developing mechanistically rigorous computational models of materials response under imposed

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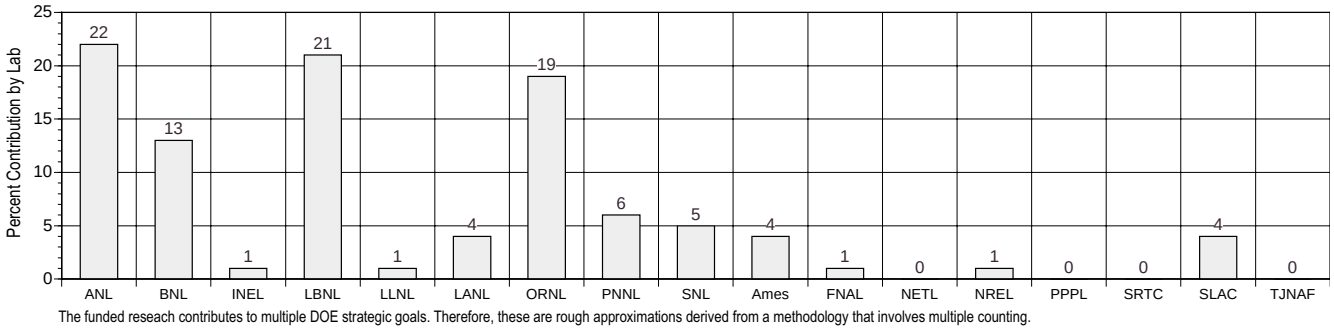
Fiscal Year 2000 Funding Profile



The funded reseach contributes to multiple DOE strategic goals. Therefore, these are rough approximations derived from a methodology that involves multiple counting.

R&D Activity: Combustion-Related Research, Advanced Materials, Engineering Sciences, and Catalysis and Chemical Transformations

R&D Activities (continued)

electrical fields and thermal and environmental stimuli, drawing upon fundamental structural models and theories as needed. The basic research program specifically targets the needs of the DOE technology programs and, therefore, has significant impacts on energy generation, transmission, conversion, and conservation technologies. This research is conducted at national laboratories and universities. Significant research that brings together basic and applied researchers takes place under the distributed Center of Excellence for the Synthesis and Processing of Advanced Materials.

Engineering Sciences: Research to help resolve the numerous engineering issues that arise from energy production and use. Research includes work in three technical areas: (1) mechanical systems, including fluid mechanics, heat transfer, and solid mechanics; (2) systems sciences, including process control, instrumentation, and intelligent machines and systems; and (3) engineering analysis, including nonlinear dynamics, data bases for thermophysical properties, models of combustion processes for engineering applications and foundation of bioprocessing of fuels, and energy-related waste and materials. This research is conducted principally at national laboratories and universities.

Catalysis and Chemical Transformations: Basic research on chemical transformations and conversions central to new or existing concepts of energy production and storage. The emphasis is on understanding the fundamental chemical principles. Catalysis is a chemical process found widely in nature and used extensively in industry because it removes energy barriers to chemical reactions. Catalysts used for refining petroleum or manufacturing chemicals are important because they reduce process energy, speed up production, and make possible the manufacture of new materials. Models for catalytic action are limited in scope and applicability. The catalysis program seeks to gain understanding of catalysis at the molecular level to allow the development of general theories and models of catalytic action. The program includes both heterogeneous (multiple phases such as liquid/solid) and homogeneous (single-phase) catalysis. Research in heterogeneous catalysis seeks to characterize the role of surface properties on molecular transformations and the structural relationships between oxide surfaces and reaction pathways, especially in the acid and redox catalysts commonly encountered in industrial applications. Research in homogeneous catalysis seeks to characterize the activation and subsequent reactions of carbon-hydrogen bonds and the role of bonding and molecular structure on the catalytic processes. The program constitutes the largest single component of the nation's basic research portfolio focused on chemical catalysis. This research is conducted at national laboratories and universities.

Science | **Strategic Goal: Protect Our Living Planet**

Program Area: Sources and Fate of Energy Byproducts

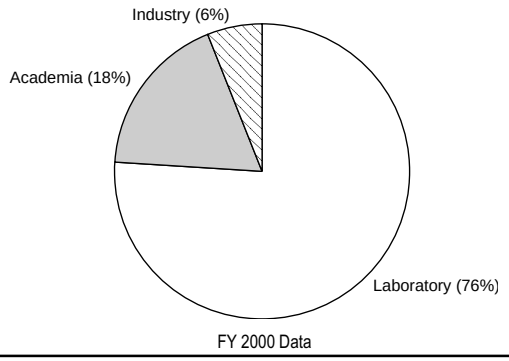
R&D Activity: Sources and Transport in the Biosphere, and Chemical Interactions and Transformations

DOE Programs

Program: Science

Office: Biological and Environmental Research
Basic Energy Science

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- Develop the scientific foundations to understand and protect our living planet from the adverse impacts of energy supply and use, support long-term environmental cleanup and management at DOE sites, and contribute core competencies to interagency research and national challenges in the biological and environmental sciences.
- To understand the molecular, atmospheric, geological, and biological pathways of energy byproducts in the biosphere.

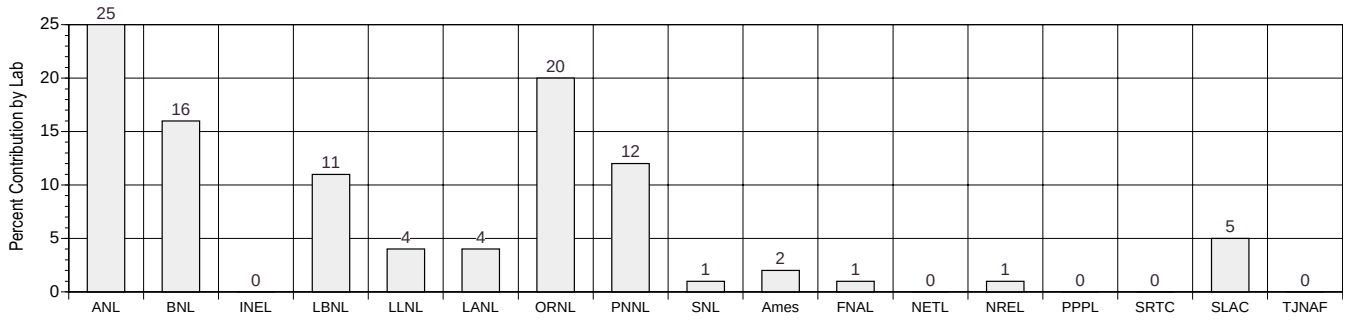
R&D Activities

Sources and Transport in the Biosphere: Basic research on fundamental geological, atmospheric, and biological processes responsible for transporting, concentrating, and localizing energy byproducts in the subsurface, the atmosphere, oceans, and the terrestrial environment. A key component is the development and use of state-of-the-art instrumentation and facilities needed to understand these processes. Emphasis is placed on understanding atmospheric processes that affect air quality and climate change, and on determining the mechanisms that regulate the balance of carbon between the atmosphere, and terrestrial and aquatic ecosystems. A major uncertainty of the greenhouse gas and potential climate change issue is what happens to the excess carbon dioxide (CO2) generated from the burning of fossil fuels. AmeriFlux experiments measure CO2 fluxes at sites across North America to estimate carbon sequestration by terrestrial ecosystems. Scientists are developing analytical chemistry techniques, including sensors, for radiation and chemical monitoring. Through this, researchers are characterizing basic chemical, physical, geological, and biological processes affecting contaminant transport in the biosphere. Emphasis is placed on studies of tropospheric ozone and particulate matter to better characterize and predict air quality. Characterization of microbial communities in coastal and subsurface environments aids in understanding the role of microbes in the cycling of carbon and nitrogen and the behavior of other energy byproducts. Research in this area is conducted at national and other government laboratories, universities and, to a lesser extent, industrial firms.

Chemical Interactions and Transformations: Research on fundamental mechanisms and pathways for biotransformation and biodegradation of contaminant mixtures and for chemical reactions and interactions of energy byproducts in the subsurface and the atmosphere. Research is

[Continued on page 2]

Fiscal Year 2000 Funding Profile



The funded reseach contributes to multiple DOE strategic goals. Therefore, these are rough approximations derived from a methodology that involves multiple counting.

R&D Activity: Sources and Transport in the Biosphere, and Chemical Interactions and Transformations

R&D Activities (continued)

primarily conducted at national laboratories and universities. Studies are underway to determine the mechanisms and potential of microbes and microbial consortia to biotransform, biodegrade, and sequester energy byproducts such as plutonium, uranium, actinides, chromium, lead, and organic solvents. Research in the chemistry of photochemical oxidants and atmospheric aerosols is being conducted to improve atmospheric models that predict the atmosphere's response to future levels of pollutants. Basic research on actinide chemistry is also emphasized because of the importance of these elements to nuclear and medical technologies and to aid in the remediation of former weapons production sites. Research in the chemistry of photochemical oxidants and atmospheric aerosols is being conducted to improve atmospheric models that predict the atmosphere's response to future levels of pollutants and to provide a sound scientitific basis for strategies and policies intended to protect and enhance air quality.

Science | **Strategic Goal: Protect Our Living Planet**

Program Area: Impacts on People and the Environment

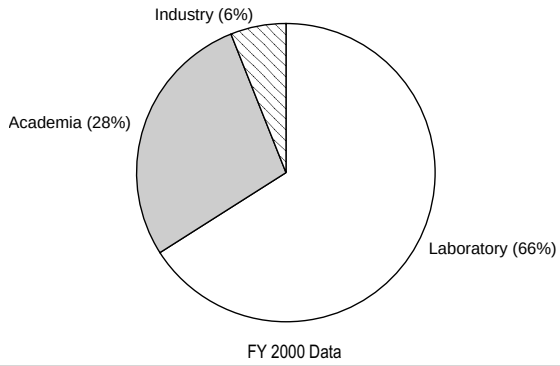
R&D Activity: Human Health Impacts and Risks, Ecosystem Responses, and Regional and Global Consequences

DOE Programs

Program: Science

Office: Biological and Environmental Research

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- Develop the scientific foundations to understand and protect our living planet from the adverse impacts of energy supply and use, support long-term environmental cleanup and management at DOE sites, and contribute core competencies to interagency research and national challenges in the biological and environmental sciences.[1]
- To understand and evaluate the effects of energy byproducts on people and the biosphere.

R&D Activities

Human Health Impacts and Risks: Research on the health effects of low-dose or low-dose-rate exposures to radiation builds on these previous studies and takes advantage of new knowledge and tools gained from the Department's human genome and structural biology research. The goal is to ascertain the health effects, from cells to whole organisms, from low-dose-rate exposures to energy and defense-related insults to ionizing radiation. This program will provide information that will decrease the uncertainty of risk at low levels, help determine the shape of the dose-response relationships after low level exposure, and achieve acceptable levels of human health protection at the lowest possible cost. Research is currently conducted at national laboratories and universities, and, to a lesser extent, other government laboratories. The program includes research to identify and characterize (1) differences or similarities between the biological damage from and responses to low doses of radiation versus normal oxidative processes in cells; (2) whether there are thresholds for low dose radiation; (3) genetic factors that affect individual sensitivity to and risk from radiation; and (4) how we communicate research results.

Ecosystem Responses: Research conducted to understand responses of terrestrial ecosystems and organisms to changes in climate and atmospheric composition, such as temperature, moisture, and CO2. This research will improve our understanding of (1) how terrestrial organisms and ecosystems respond to simultaneous changes in the composition of the atmosphere and in climate, (2) the biological or ecological mechanisms or pathways leading to those responses, and (3) the extent to which the responses are seen across different levels of the terrestrial ecosystem that affect humans positively or negatively. Research is conducted primarily at national laboratories and universities.

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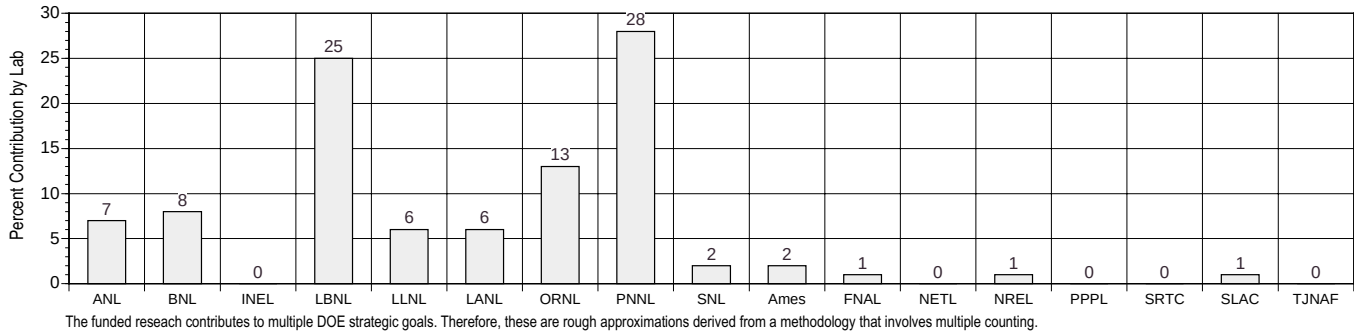
Fiscal Year 2000 Funding Profile



The funded reseach contributes to multiple DOE strategic goals. Therefore, these are rough approximations derived from a methodology that involves multiple counting.

Science **Strategic Goal: Protect Our Living Planet**

Program Area: Impacts on People and the Environment

R&D Activity: Human Health Impacts and Risks, Ecosystem Responses, and Regional and Global Consequences

R&D Activities (continued)

Regional and Global Consequences: Various basic research activities addressing regional and global consequences of energy-generated and related byproducts. Climate Change Prediction Program develops models that predict future climate given present and projected modifications such as changes in greenhouse gases. Efforts include increasing computational capabilities, the speed of computations, and the resolution and validity of the models. The models feed into a national effort coordinated with other agencies, including the National Science Foundation at the National Center for Atmospheric Research (NCAR). The Department's efforts have a primary focus on decade-to-century climate simulations. Capability to accurately simulate climate is currently limited by lack of understanding and modeling of the effects of clouds in climate. The Atmospheric Radiation Measurement Program (ARM) uses heavily instrumented sites and long-term observations to provide data and modeling improvements for climate prediction. Models are also developed for terrestrial carbon processes that, when coupled with atmosphere-ocean carbon models, estimate the rate and timing of atmospheric CO2 change. Information from modeling efforts is integrated into efforts to assess the costs and impacts of potential changes in climate, including potential actions to ameliorate climate change. Research is conducted at national laboratories, universities, industrial firms, other government laboratories, and, to a minor extent, internationally.

Science | **Strategic Goal: Protect our Living Planet**

Program Area: Prevention and Protection

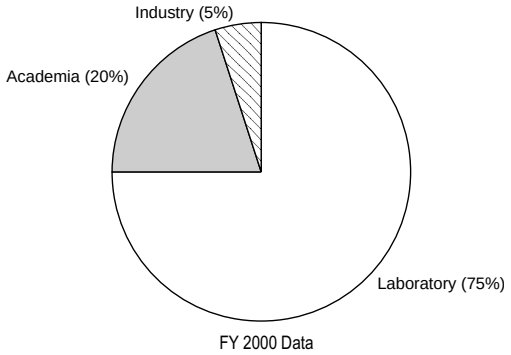
R&D Activity: Pollution Minimization, Cleanup and Remediation, Carbon Sequestration, and Health Protection – Regulation and Medicine

DOE Programs

Program: Science

Office: Biological and Environmental Research
Basic Energy Science

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- Develop the scientific foundations to understand and protect our living planet from the adverse impacts of energy supply and use, support long-term environmental cleanup and management at DOE sites, and contribute core competencies to interagency research and national challenges in the biological and environmental sciences.
- To create new scientific approaches to protect the biosphere from the effects of energy byproducts.

R&D Activities

Pollution Minimization: Broad range of basic research support for pollution minimization with important implications for energy production and use. The DNA sequence and functional capabilities of microbes that produce methane or hydrogen, for example, are characterized. This information, coupled with structural and computational biology research, provides opportunities for the use and redesign of microbes for energy uses. Engineering research is conducted on combustion and fuel bioprocessing for more efficient fuel use and waste minimization. Research on non-automotive battery systems improves battery size, weight, life, and recharge cycles. Research is conducted primarily at national and other government laboratories and universities and, to a lesser extent, industrial firms.

Cleanup and Remediation: Natural and Accelerated Bioremediation Research (NABIR) provides fundamental science that serves as the basis for developing cost-effective bioremediation of radionuclides and metals in the subsurface at DOE sites; understanding intrinsic bioremediation and opportunities for accelerated bioremediation using chemical and microbial amendments; integrating bioremediation with conventional physical-chemical remediation to accelerate site cleanup; and evaluation of bioremediation by regulators, local communities, and other stakeholders. NABIR emphasizes characterization and use of microbes and microbial communities with bioremedial potential. The William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) operates more than 100 leading-edge computational and research systems as part of a national collaboratory user facility for molecular level environmental research. Research is also supported on fundamental molecular level questions underlying the most energy-consuming industrial process, separations, a key component of environmental cleanup. Research is conducted at national laboratories, universities, and industrial firms.

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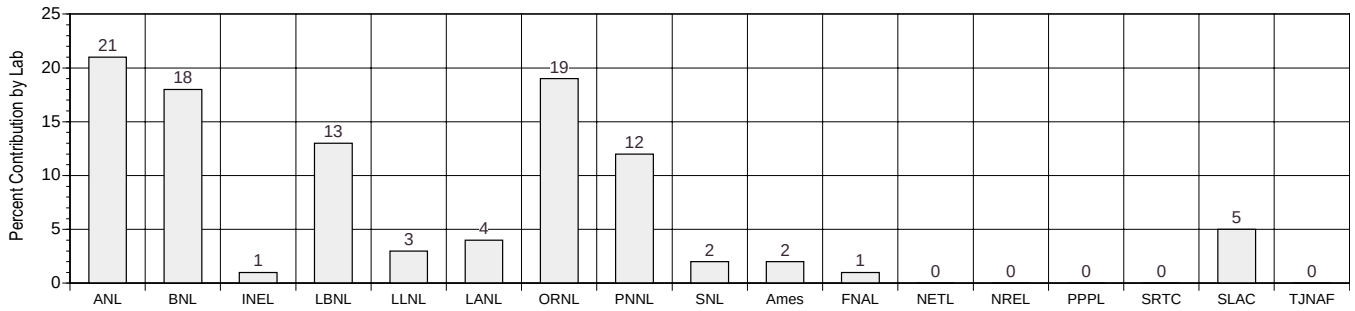
Fiscal Year 2000 Funding Profile



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Science | Strategic Goal: Protect Our Living Planet

Program Area: Prevention and Protection

R&D Activity: Pollution Minimization, Cleanup and Remediation, Carbon Sequestration, and Health Protection – Regulation and Medicine

R&D Activities (continued)

Carbon Sequestration: Basic research into the biological processes that drive carbon exchange between the oceans and the atmosphere and between the atmosphere and the terrestrial environment. Genomic DNA sequences will be determined for microbes that play a role in the sequestration of carbon in the oceans or the terrestrial biosphere. Options for storing excess carbon in the deep oceans, in subsurface geologic structures, or using biological solutions will be investigated. Research will be conducted at national laboratories, universities, and industrial firms.

Health Protection: Regulation and medicine – scientific research to support national decision-making and decrease uncertainty of determining health risks from low-level radiation exposures, to help determine the shape of the dose-response relationships after low level exposure, and to achieve acceptable levels of human health protection at the lowest possible cost. Radiolabeled molecules are developed for noninvasive studies of metabolic and physiological processes and for the diagnosis and treatment of disease. New, sensitive, high-resolution positron emission tomography (PET) instruments for radiotraacer imaging and magnetoencephalography (MEG) for probing the tiny magnetic fields in the brain are being developed. Medical applications of lasers are also emphasized. New imaging technology will be used to "see" genes in action, as a molecular monitor for vital organ function, and to monitor the effects of chemo-, radio- and gene-therapy. A new Biomedical Engineering research program has been initiated that includes research on tissue engineering, molecular biosensors, medical imaging, virtual reality, robotics and micromachines, and biomaterials. Compounds are being developed for boron neutron capture therapy (BNCT), a cancer treatment based on the interaction of boron-containing compounds with thermal neutrons that can theoretically kill cancer cells without affecting surrounding normal cells. Research is conducted at national laboratories, universities, and government laboratories.

Science | **Strategic Goal: Exploring Energy and Matter**

Program Area: Components of Matter

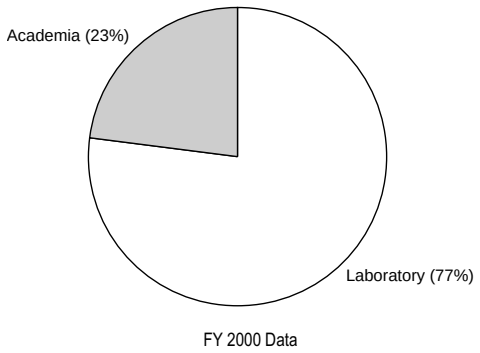
R&D Activity: Elementary Particles and Their Interactions, Nuclear Matter and Interactions, Atoms and Molecules, and Biomolecular Building Blocks

DOE Programs

Program: Science

Office: High Energy Physics
Nuclear Physics
Basic Energy Sciences,
Biological and Environmental Research
Advanced Scientific Computing Research

Laboratory-Academia-Industry Participation



FY 2000 Data

Strategic Goals and Objectives

- Explore matter and energy as elementary building blocks from atoms to life, expanding our knowledge of the most fundamental laws of nature spanning scales from the infinitesimally small to the infinitely large.
- To understand matter at the most fundamental level.

R&D Activities

Elementary Particles and Their Interactions: Fundamental research to explore and understand the nature and origin of the differences in behavior between matter and anti-matter, e.g., violation of symmetry in charge conjugation parity (CP) that is inconsistent with the Standard Model; experiments to determine whether neutrinos have mass and to determine their nature; search for the Higgs Boson particle predicted by the Standard Model which, if found, could help to confirm the existence of supersymmetry and possibly double the elementary particle spectrum; search for other rare particles in collisions of protons and antiprotons, protons and protons, or of electrons and protons, that reveal symmetries at ever smaller distances, supporting the theory of supersymmetry; experiments into electroweak interactions to further understand and refine the Standard Model; precision experiments designed to understand the spectrum of hadron masses and properties and supporting quark structures; research exploring how the spin structure of nucleons is affected by the spin of its internal constituents, quarks and gluons; theoretical research employing advanced computation and simulation as a framework for understanding phenomena involving fundamental particles, the Standard Model, and unification of forces; research into more sensitive, accurate, and radiation hardened particle detectors and electronics leading to technologies with spinoff applications; research into conventional and advanced particle accelerator concepts that break the constraints of current limits posed by present physical structures and materials-superconductivity, very high powered radio frequency sources, and so forth.

Nuclear Matter and Interactions: Fundamental research in nuclear matter and interactions directed toward the challenges of understanding the strong force binding nuclei together as well as the smaller constituent particles that form the nucleons that make up the nucleus. Nuclear matter is studied under extreme conditions of temperature and pressure that may give rise to possible quark-gluon plasmas or other new states of matter.

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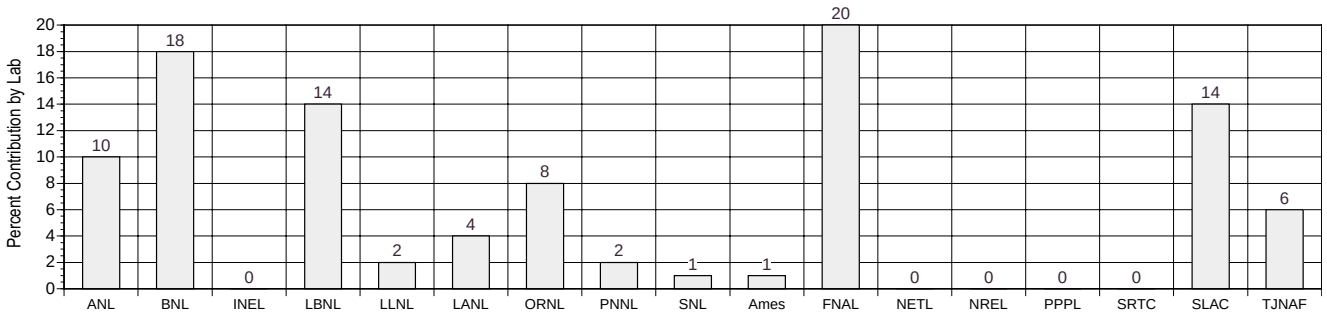
Fiscal Year 2000 Funding Profile



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R&D Activity: Elementary Particles and Their Interactions, Nuclear Matter and Interactions, Atoms and Molecules, and Biomolecular Building Blocks

R&D Activities (continued)

Nuclei formed at the limits of angular momentum and neutron/proton ratio probe the limits of nuclear binding. Electron scattering and electromagnetic excitation can probe details of nuclear structure and the nucleons themselves. In pursuing these research directions information can be obtained that is critical to our understanding of cosmic events such as nucleosynthesis in the Big Bang and in supernova, as well as to refine the Standard Model. Advanced computational and technology research plays a vital role in experimentation and theoretical efforts and future activities will be increasingly demanding of computational ability.

Atoms and Molecules: Research to understand the properties of solids, liquids, glasses, surfaces, thin films, and artificially structured and multicomponent materials at the atomic and molecular levels, significantly improving our ability to control and harness matter and to envision and create new materials for different applications. Research addressing condensed matter physics, condensed matter theory, the behavior behind particle-solid interactions, and atomic, molecular and optical science. Breakthoughs in understanding can lead to better superconductors, better semiconductors and photovoltaics, improved lasers, stronger magnets, and other material breakthroughs. Particular challenges and opportunities exist in high temperature superconductivity, including the electronic structure and properties of complex, multicomponent materials, and improved understanding of the phenomenon of giant or colossal magnetoresistance

Biomolecular Building Blocks: Basic research on proteins and DNA molecules that are and contain the information for the building blocks of life. Understanding proteins and other biomolecular building blocks is fundamental to scientific understanding of the human genome, and the genomes of plants and microbes. Understanding genomic structures has broad applications in energy, the environment, medicine, agriculture, and industry. Research activities in biomolecular building blocks are centered on the function and dynamic behavior of protein complexes since proteins generally do not work alone. Emphasis is placed on proteins that recognize and repair damage to DNA and that are involved in the bioremediation of metals and radionuclides. Research is also underway to develop a comprehensive understanding of the complete workings of a microbial cell, from the DNA sequence, to the identification of all the genes, to the production of all the proteins whose assembly instructions are contained in the genes, to the complex interaction of the genes and proteins in a cell that give the microbe its life and its unique characteristics and behaviors.

Science | **Strategic Goal: Exploring Energy and Matter**

Program Area: Origin and Fate of the Universe

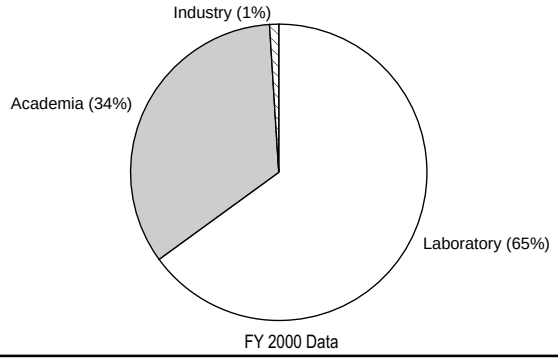
R&D Activity: Beginning of the Cosmos, Creation of Nuclei and Matter, Evolution of Astrophysical Structures, Formation of Life

DOE Programs

Program: Science

Office: High Energy Physics
Nuclear Physics
Advanced Scientific Computing Research

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- Explore matter and energy as elementary building blocks from atoms to life, expanding our knowledge of the most fundamental laws of nature spanning scales from the infinitesimally small to the infinitely large.
- To understand the evolution of the universe from fundamental laws.

R&D Activities

Beginning of the Cosmos: Fundamental research builds closer connections among research areas of high energy and nuclear physics, cosmology, astrophysics and gravity. Interdisciplinary research addresses the early moments of the Big Bang expansion of the universe as it flowered into existence, the microscopic origin of the observed cosmic asymmetry between matter and antimatter, the nature of dark matter which is thought to dominate the matter content of the universe, the possibility of "dark energy", the formation of structure in the universe, and the ultimate fate of the Universe (whether it will expand indefinitely, and at what rate, or ultimately contract, and whether there might be multiple universes), and development of theories pertaining to quantum gravity (so-called super-string theories). Experiments search for particle dark matter; survey large redshift supernovas and galaxies; seek to understand the small anisotropy of the cosmic microwave background; study the highest-energy cosmic rays; and search for proton decay, magnetic monopoles and neutrino masses. A major goal is to determine the fundamental parameters of the universe itself, in the context of Einstein's Theory of General Relativity. This research is carried out at universities and national laboratories.

Creation of Nuclei and Matter: Fundamental research that sheds light on the early creation of matter in the universe. Research efforts include recreation of conditions in the laboratory and study of the behavior of nuclear matter at temperatures and densities comparable to those that existed after the Big Bang. Understanding the origins of CP violation and baryon asymmetry is central to this research. Understanding the relative abundance of the light atoms is also a focus. Using relativistic heavy ion collisions, nuclear physics experiments study the behavior of hot, dense nuclear matter and search for evidence of a "quark-gluon plasma" and the phase transition to normal hadronic matter. High energy physics

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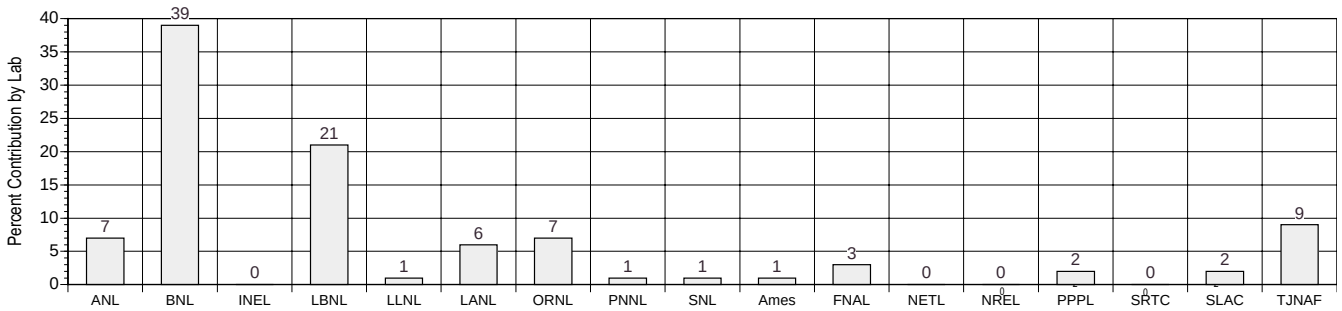
Fiscal Year 2000 Funding Profile



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R&D Activity: Beginning of the Cosmos, Creation of Nuclei and Matter, Evolution of Astrophysical Structures, Formation of Life

R&D Activities (continued)

experiments have measured the proton lifetime to be more than 10^{32} years, for the most probable modes of decay. Theories that unify the electroweak and strong forces are sought and currently predict that protons decay with a lifetime in a range perhaps just beyond the reach of current experiments. Along with proton decay, these theories predict the possible existence of magnetic monopoles, relic particles created in the Big Bang carrying units of magnetic charge, analogous to electric charge. Magnetic monopoles are sought in high energy physics experiments. Theories predict the possible existence of even stranger objects, among them cosmic strings, of enormous length and mass. These may have existed since the Big Bang, and if so would have been instrumental in the formation of galaxies. Other experiments in high energy and nuclear physics have searched for violation of lepton number, and have set stringent limits on such processes. Experiments are proposed to search for antimatter in cosmic radiation.

Evolution of Astrophysical Structures: Basic research to understand, from first principles, the origin and evolution of stars, galaxies, and other astrophysical structures. Direct searches are underway for dark matter, neutrino mass, magnetic monopoles, supernovas, and high energy cosmic sources. The calculations relating to Black Holes, supernova dynamics, and the seeding of galaxies comprise much of the current theoretical activities. New accelerator facilities and instrumentation are being developed to measure critical nuclear reaction rates for element formation. In particular, the concept is being developed for a new accelerator, the Rare Isotope Accelerator, that will produce intense radioactive beams far from stability.

Formation of Life: Research into the details of key microbes provides insights on the workings of some of the most minimal forms of life, some of which inhabit environments notable for extremes of temperature, pressure, acidity, and salinity, as well as high concentrations of toxic chemicals and even high fluxes of radiation. Beyond improvements in our understanding of evolution and the origins of life, benefits will undoubtedly extend to medicine, agriculture, industrial processes, and not least, environmental bioremediation-the latter an important issue at numerous Department of Energy sites. Research activities include the identification of primitive microorganisms with potentially useful properties for bioremediation, as well as industrial, medical, and agricultural applications, with particular attention devoted to simple organisms capable of surviving in extreme environments; continued examination of intracellular processes (including life cycle and repair mechanisms, and enzymes) that regulate the life control of simple organisms; potential evolutionary aspects of simple organisms; and development of methods to accelerate genetic sequencing and structural biology research leading to high throughput technologies for providing information on gene structure. Research is carried out at national laboratories and universities.

Science | **Strategic Goal: Exploring Energy and Matter**

Program Area: Complex Systems

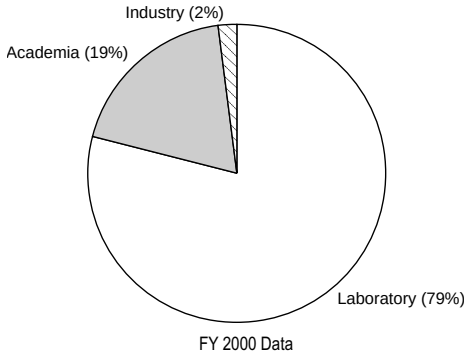
R&D Activity: Collective Phenomena and Adaptive Systems

DOE Programs

Program: Science

Office: Basic Energy Science
Biological and Environmental Research
Fusion Energy Sciences
Advanced Scientific Computing Research

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- Explore matter and energy as elementary building blocks from atoms to life, expanding our knowledge of the most fundamental laws of nature spanning scales from the infinitesimally small to the infinitely large.
- To understand and control complex systems of matter, energy, and life.

R&D Activities

Collective Phenomena: Multidisciplinary basic research to understand complex systems --systems composed of many elements that exhibit unique behavior patterns, which may be called "collective phenomena." Research spans the materials, chemical, plasma, geological, engineering, geological plant and microbial sciences. Research in chemistry, materials, geosciences, and biosciences covers lengths from the atomic scale to the cellular scale to the meter scale and times from femtoseconds to millennia. For example, theory and simulation of plasma behavior in both magnetic and inertial fusion is complex because of the many orders of magnitude in spatial and temporal scales involved. Research into collective phenomena include non-equilibrium systems, functional synthesis, control of entropy, strongly coupled systems, and heterogeneous systems. The various research bridges the gap between an atomic level understanding (reductionist view) and a continuum mechanics understanding (classical view) of complex and collective phenomena. Research is conducted predominantly at national laboratories and universities.

Adaptive Systems: Research on complex, adaptive systems exploring the behavior of macroscopic collections of individual units endowed with the potential to evolve in time. Their interactions lead to coherent behavior that can be described only at higher levels than those of the individual units. Hence, the whole is more than the sum of its components. Research into life forms that survive by adapting to change sheds light on the fundamental organizing principles that are at work; these are the concern of fundamental studies in complexity. Two major research areas are concerned with understanding gene function and ecological processes. The research in these areas is conducted at national laboratories, universities and industrial firms. Research on gene function provides information needed to understand the structure and function of the proteins and RNAs encoded by the human (and other) genome and to understand the nature of the regulatory networks that control expression of multiple

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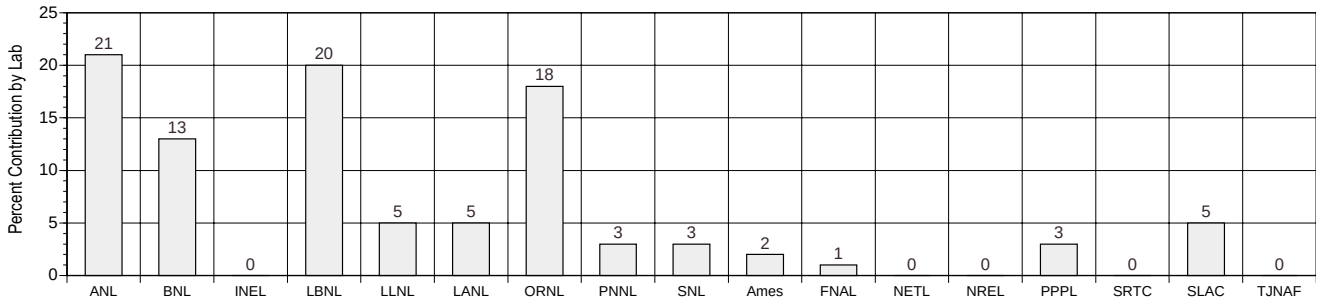
Fiscal Year 2000 Funding Profile



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R&D Activity: Collective Phenomena and Adaptive Systems

R&D Activities (continued)

genes in space and time. This information is fundamental to our understanding of the human genome and the genomes of microbes with broad applications in energy, the environment, medicine, agriculture, and industry. Research on ecological processes advances scientific understanding of responses of terrestrial ecosystems and organisms to changes in climate and atmospheric composition, such as alterations in temperature and moisture and increases in carbon dioxide concentration. Objectives are to improve understanding of (1) the responses of terrestrial organisms and ecosystems to simultaneous changes in atmospheric composition and climate; (2) the causal mechanism or pathway of the responses and the biological and ecological processes controlling the responses; and (3) the extent to which the responses are manifested across different organizational (hierarchical) levels of terrestrial ecosystem components and processes of value to humans.

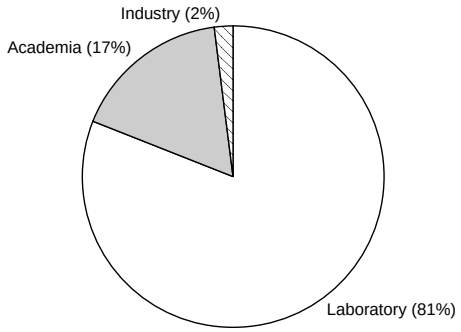
R&D Activity: Scientific Research Facilities

DOE Programs

Program: Science

Office: Basic Energy Science
Biological and Environmental Research
Fusion Energy Sciences
High Energy Physics
Nuclear Physics
Advanced Scientific Computing Research

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- Provide the extraordinary tools, scientific workforce, and multidisciplinary research infrastructure that ensures success of DOE's science mission and supports our Nation's leadership in the physical, biological, environmental, and computational sciences.
- To provide research facilities that expand the frontiers of the natural sciences.

R&D Activities

Accelerators for High Energy and Nuclear Physics: Leading-edge research tools, often of enormous size, energy, and complexity that enable scientists to probe fundamental questions about the nature of matter and energy. Facilities Fermilab are used to study neutrinos, B-mesons, known and new particles, and unusual states of matter. Fermilab has a large and well-equipped facility for assembling silicon microdetectors, a world-class data processing center, and an active group of theoretical physicists. It also serves as the host center for the U.S. efforts on the CMS detector and on the magnet development program for the Large Hadron Collider (LHC) accelerator. Brookhaven National Laboratory serves as the host center for U.S. efforts on the ATLAS detector for the LHC accelerator. SLAC research facilities produce electrons and positrons, support the operation of the B-factory, and detect and measure the particles resulting from the collisions therein. The Alternative Gradient Synchrotron (AGS) facility accelerates protons at 24 GeV, providing the world's highest intensity proton and kaon beams. These beams are used for forefront high energy and nuclear physics fixed target research aimed at understanding the fundamental structure of matter and energy. Four major accelerators have either just started operations or will be operating by the year 2000: the CEBAF at the Thomas Jefferson National Accelerator Facility (TJNAF), which will open a new window on the role of quarks in nuclei; the RHIC, which will collide gold nuclei at 100 GeV per nucleon in search of the quark-gluon plasma which existed a hundredth of a second after the Big Bang; the Main Injector at Fermilab, which by raising the intensity of the beam by a factor of 5-10, will provide the opportunity to exploit the discovery of the top quark and search for other new particles such as a light Higgs; and the B-Factory at SLAC, which is studying the properties of the interaction that breaks the symmetry between matter and anti-matter, called charge-parity violation. Together, these leading-edge facilities will allow a significant improvement in the fundamental

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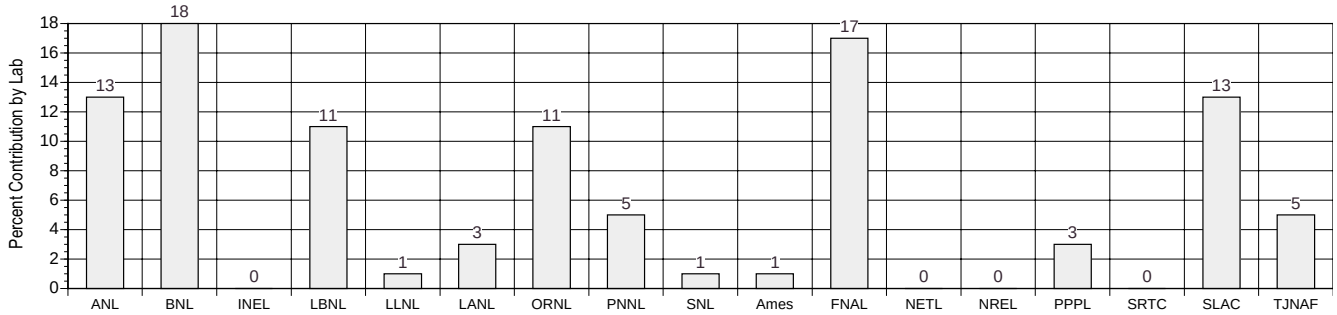
Fiscal Year 2000 Funding Profile



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R&D Activity: Scientific Research Facilities

R&D Activities (continued)

understanding of the nature of matter. Modern physics research, in many cases, requires probe particle beams of great energy (billions and trillions of electron volts), very high currents, and exceptionally precise optical control. The science and technologies fundamental to building and operating such machines are highly specialized; ongoing R&D supports continual improvements in advanced computer modeling, simulation and control software, and instrumentation for measuring particle beams.

Light Sources and Neutron Beam Facilities for Natural and Life Sciences: Preeminent tools of science that improve our understanding of the fundamental interactions of photons, neutrons, electrons, and ions with matter, pending knowledge that can be used to design probes for materials sciences and related disciplines. Such information has made it possible for researchers to build the advanced machines and instrumentation necessary to create, manipulate, focus, and detect a large variety of beams of electromagnetic radiation and particles. As a result, new complex spectroscopic, scattering, and imaging techniques have been developed. These techniques further basic research in a wide variety of disciplines. Examples of investigations at the facilities include materials characterization, processing, and design; chemical kinetics, reaction dynamics, and reaction diagnostics; the molecular basis of geochemistry and environmental chemistry; and understanding materials under extremes of temperature and pressure for geophysical and earth sciences.

Plasma and Fusion Energy Facilities: Advanced facilities for the scientific study of plasmas under various conditions and magnetic fields. Each of the three large fusion devices, as well as smaller facilities located at universities, provides a focus for participation by extended collaborative teams. The NSTX is being built as an innovative confinement concept in which the magnetic fields are not large. It began operating in 1999, with full scale experimental operations starting in 2000. The DIII-D facility is the largest operating magnetic fusion experiment in the United States that focuses on the advanced tokamak concept and has a 2.2 Tesla (T) field. By contrast the Alcator C-Mod facility is a high-field (8-9 T) user facility with currents much like DIII-D, namely 2.5 MA. Medium-grade experiments exploring alternative concepts are located at various universities, including the University of Wisconsin and UCLA.

Single-Purpose and Multidisciplinary Facilities: Various facilities for conducting advanced scientific experiments and investigations. The William R. Wiley Environmental Molecular Science Laboratory (EMSL) at PNNL is a unique national scientific user facility. With over 100 leading edge instrument and computer systems in one facility, the EMSL provides users with the capability to undertake molecular-level research on environmental issues in an interdisciplinary environment. Collectively, the electron beam microcharacterization centers embrace transmission, scanning, scanning-transmission, analytical, high and atomic resolution, high voltage, and environmental electron microscopies; atom probe and field ion microscopies; mechanical properties or microindentation instruments; atomic force microscopy; and nuclear microanlaysis. The Combustion Research Facility at Sandia-Livermore serves a broad array of university users exploring theoretical and experimental combustion systems.

Biological and Environmental Research Facilities: Dedicated special facilities for biological and environmental sciences. Some are special beam lines and equipment stations at synchrotron light and neutron sources, and others are partially devoted to this area of research. Others are observation stations dispersed over large areas, taking regular readings of climatic conditions. Structural biology research facilities at the Argonne National Laboratory, Lawrence Berkeley Laboratory, and Stanford Synchotron Radiation Laboratory light sources investigate the sub-Ångstrom structures of proteins; other laboratories investigate PET scanning magneto encephalography and magnetic resonance imaging for single cell analysis on a fast time scale. At reactors located at MIT and McClellan Air Force Base, neutron beams are being used for clinical studies of boron neutron capture therapy. In the area of environmental studies, Field Research Centers are being established to study bioremediation of sites polluted with radionuclides. Other stations monitor carbon dioxide flow, atmospheric radiation, and water vapor through the ARM program. These efforts involve collaboration with other government agencies including NASA, NOAA, and the Department of Agriculture. The Production Sequencing Facility (PSF) is devoted to the high-speed, automated sequencing of the human genome and is a key element of the DOE Joint Genome Institute. It is a high-throughput DNA sequencing factory that will utilize and integrate advances in sequencing technology and automation, drawing on the sequencing, automation and information management expertise of DOE National Laboratories and leading experts at universities.

Computing and Computational Support: Research infrastructure and capabilities essential to the success of all the DOE science programs achieved through state-of-the-art facilities and networking. These include the NERSC computing center at Lawrence Berkeley National Laboratory and the ESNet, as well as Advanced Computing Research Facilities (ACRFs) at various DOE laboratories. In addition there are grand challenge efforts and collaboratory efforts involving the various programs.

Science | **Strategic Goal: Extraordinary Tools for Extraordinary Science**

Program Area: Scientific Simulation

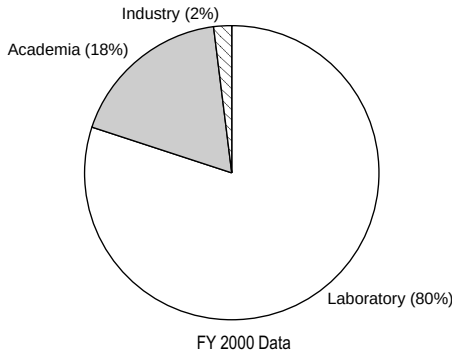
R&D Activity: Applications Software, Ultra High Performance Computational and Communications Facilities, and Computer Science and Enabling Technologies

DOE Programs

Program: Science

Office: Advanced Scientific Computing Research
Basic Energy Science,
Biological and Environmental Research
Fusion Energy Sciences
High Energy Physics
Nuclear Physics

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- Provide the extraordinary tools, scientific workforce, and multidisciplinary research infrastructure that ensures success of DOE's science mission and supports our Nation's leadership in the physical, biological, environmental, and computational sciences.
- To achieve computation and simulation as a critical tool in future scientific discovery.

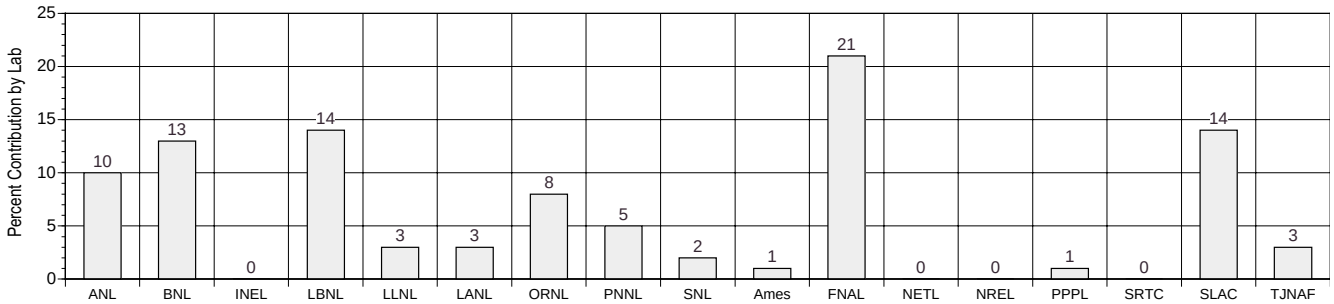
R&D Activities

Applications Software: Research to develop, test, and use advanced computer software that realistically models physical processes. Significant portions of this activity are integrated into the management of all of the science programs of the Department. Examples of the types of applications software developed include global climate and ocean models, relativistic quantum chemistry software to understand the behavior of plutonium and uranium compounds in soil, and software to model fluid flow in combustion devices. These efforts have two common objectives: first, to increase the fidelity of the mathematical models of the physical phenomena under study; and, second, to find and implement ways of translating these models into computer code in ways that achieve very high efficiency and performance. This research is primarily conducted at national laboratories and universities.

Ultra High Performance Computational and Communications Facilities: Research and technical support for many of the highest performance computing and communications facilities in the world, owned and operated by DOE. These facilities have two roles: production of scientific results which are critical for the Department's missions and development of the hardware and software technologies that are required for the next generation of computational and communications facilities. Examples are found at NERSC, the computing facilities operated by the weapons laboratories, the advanced computing research facilities operated by the Office of Science at Argonne National Laboratory, Los Alamos National Laboratory, Lawrence Berkeley National Laboratory, and Oak Ridge National Laboratory, and more specialized computing resources such as the molecular sciences computing resource at Pacific Northwest National Laboratory's EMSL. In addition to computing facilities the Office of Science operates ESnet, a high performance network which links computational and experimental facilities to users and is a critical component of the

[Continued on page 2]

Fiscal Year 2000 Funding Profile



The funded reseach contributes to multiple DOE strategic goals. Therefore, these are rough approximations derived from a methodology that involves multiple counting.

R&D Activity: Applications Software, Ultra High Performance Computational and Communications Facilities, and Computer Science and Enabling Technologies

R&D Activities (continued)

research infrastructure for the nation. Detailed planning is currently underway for the next generation of computer and communications facilities that build on the experience of ASCI and move scientific simulation to the next frontier of multi-teraflop computing for future applications.

Computer Science Enabling Technologies: Research and technical support that provide applications developers with the tools they need to make effective use of ultra-scale computer and communications facilities. These efforts provide mathematical algorithms and software, debugging and performance tuning tools, data management and visualization software, and tools to support collaboration over networks. Activities include applied mathematics and areas of computer science that are relevant for high performance computing and remote access to facilities. Researchers in computer science and enabling technology are working to overcome significant challenges and to enable important scientific applications. Software must be designed to support machines not only for the near future but for the next decade. Complex applications must be managed to incorporate more sophisticated physical models, using advanced numerical techniques, and begin to be combined into large-scale "simulation systems" that include the linkage of two or more previously stand-alone models (e.g., ocean-atmosphere- biosphere or fluid-structures-chemistry). Development and user environments must enable ubiquitous collaboration and distributed computing capabilities to support large interdisciplinary teams. Researchers must extract insight from, manage, and visualize petabyte scale data archives. Applications scientists and computer scientists and mathematicians are working toward more effective long-term collaborations.

Program Area: Institutional Capacity

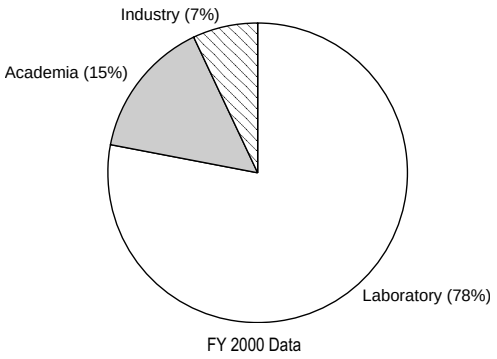
R&D Activity: National Laboratory System, Science Education, and Broadening the Scope of S&T Performers

DOE Programs

Program: Science

Office: Basic Energy Science
Biological and Environmental Research
Fusion Energy Science
High Energy Physics
Nuclear Physics
Advanced Scientific Research

Laboratory-Academia-Industry Participation



Strategic Goals and Objectives

- Provide the extraordinary tools, scientific workforce, and multidisciplinary research infrastructure that ensures success of DOE's science mission and supports our Nation's leadership in the physical, biological, environmental, and computational sciences.
- To strengthen the Nation's institutional and human assets for basic science and multidisciplinary research.

R&D Activities

National Laboratory System: Stewardship of five multiprogram national laboratories and five major program-dedicated laboratories. The Office of Science has landlord responsibility for general purpose plant (GPP) and general purpose equipment (GPE) at all ten of these laboratories. Total funding for GPP/GPE for the multiprogram labs was $45.5M in FY 98 and $46.7M in FY 99. SC programs support GPP funding (which is for small construction projects up to $5M) and GPE funding at Argonne, Brookhaven, Lawrence Berkeley, Oak Ridge, and Pacific Northwest National Laboratories. The Director, Office of Science, is the cognizant Secretarial Officer responsible for the institutional management of these laboratories, including the Laboratory Institutional Planning, Work for Others, and Laboratory Directed Research and Development processes. Implementation of these and SC program responsibilities helps ensure effective support and advocacy of integrated safety management, performance-based management, nonprofit contract policy, and the laboratories operating as a system. Together these laboratories have more than 1000 buildings with 14.9 million gross square feet of space and a multitude of unique scientific facilities at an estimated replacement value of over $10.5 billion. The Office of Science helps ensure mission readiness of these laboratories and helps preserve the Federal investment in these unique institutions. The SC program funding at these laboratories ranges from 70% to 20% of total laboratory funding. Total support of the infrastructure at Ames, Fermi, Princeton Plasma Physics Laboratory, Stanford Linear Accelerator Center, and the Thomas Jefferson Accelerator, where SC provides almost all of the funding, comes from the SC budget. Also, all the laboratories fund maintenance and ES&H from their overhead accounts, which come out of program budgets. These totaled $98M in FY97, based on functional cost data submissions from the labs.

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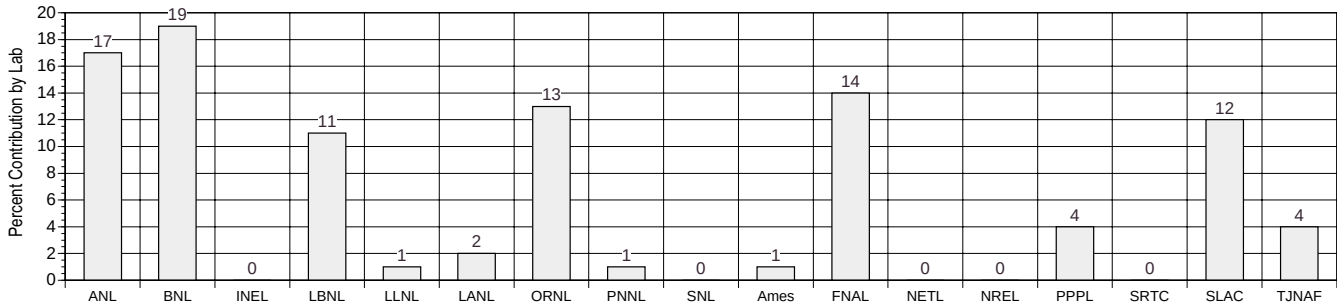
Fiscal Year 2000 Funding Profile



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R&D Activity: National Laboratory System, Science Education, and Broadening the Scope of S&T Performers

R&D Activities (continued)

The Office of Science also provides general infrastructure support for the backlog of general purpose facility needs at the aging SC laboratories at a level of about $20M per year. The Multiprogram Energy Laboratory Facilities Support (MELFS) program has been in existence since 1981 and has invested $421M in the SC multiprogram lab infrastructure over the years. Seventy percent of these funds ($280M) addressed utility and ES&H needs while 10% ($40M) provided new buildings. As a result, these investments have corrected life safety hazards, improved health standards, reduced environmental liabilities, provided reliable utility services, reduced operating costs, and improved operating efficiencies. The program also provides funds for Payment In Lieu of Taxes (PILT) to local governments for two SC laboratories (Argonne and Brookhaven) as allowed by the Atomic Energy Act of 1954

Science Education: A broad range of direct and leveraged indirect support for national science education. Half a billion a year of peer reviewed basic research in universities, plus an additional $500M for operating the SC scientific facilities at the laboratories for university science-based users is considerable leverage for science education. This represents the Department's largest program contributing to the university research base and to the education and training of graduate students and post docs produced by these universities to meet future scientific manpower needs. The Office of Science program support of university and national laboratory research impacts about 3500 graduate students and post docs each year. This is an important DOE contribution to replenishing the overall U.S. scientific pool. It is also a source of new scientific talent for DOE and its laboratories. Thousands of university graduate students use SC's major scientific user facilities to perform their research. For example, out of the 2300 scientists that use the National Synchrotron Light Source each year, DOE supports 700 graduate student users, and other agencies support 550 more. SC programs also provide graduate fellowships to outstanding students in specific program areas. The Basic Energy Sciences Program supports the EPSCoR at $6.8M per year at research universities and colleges in the designated eighteen states and the Commonwealth of Puerto Rico. This program also contributes to developing science and engineering manpower to help meet current and future needs. Particular emphasis is placed on exploiting the unique scientific and technical capabilities present at the DOE national laboratories to accomplish the objectives of the program. Close interactions result in establishing joint collaborative research projects between laboratory scientists and the EPSCoR state personnel. These projects, in turn, will lead to establishing nationally competitive scientific expertise at the home institutions of the EPSCoR states.

Broadening the Scope of S&T Performers: Ensuring a robust and diverse set of research performers from academia, private industry and labs, working collaboratively as part of a seamless research community. The LTR subprogram supports high-risk, multidisciplinary research collaborations between the SC laboratories and private industry. The research portfolio emphasizes advanced materials processing and utilization, intelligent processes and controls, and sustainable environments. Such work leverages the resources of both partners, since each frequently has unique facilities and complementary expertise. The partners jointly bring technology research to a point where industry or DOE's technology development programs can pursue final development and commercialization. The LTR subprogram enhances opportunities to pursue technology research that is of value to industry, complements basic research program goals, and seeks to enhance public benefit from investment in scientific research at the Office of Science laboratories. In the DOE-wide SBIR program, 2.5% of the Department's extramural R&D budget, about $76M, is set aside for a competition among small businesses. The Department's technical program offices are responsible for identifying research challenges that (1) are suitable to the capabilities of technology-based small businesses and (2) are required to fulfill mission needs. The research challenges are published as technical topics in annual solicitations and encompass a wide range of scientific subject matter, from molecularly engineered nanoscale materials, to instrumentation and concepts for high-energy accelerators to advanced fuel injection concepts for hybrid electric vehicles. The Small Business Technology Transfer (STTR) program is similar in structure to the SBIR program except that, in STTR, the small businesses must collaborate with a research institution (usually a national laboratory or a university) serving as a subcontractor. The Department sets aside 0.15% of its extramural R&D budget for competition among small businesses in this DOE-wide program. The responsibilities of the technical program offices are very similar to those in the SBIR program.

Acronyms

Department of Energy Laboratories

AMES — Ames Laboratory (Not an acronym)
ANL — Argonne National Laboratory
BNL — Brookhaven National Laboratory
FNAL — Fermi National Accelerator Laboratory
INEEL or INEL — Idaho National Engineering and Environmental Laboratory
LANL — Los Alamos National Laboratory
LBNL — Lawrence Berkeley National Laboratory
LLNL — Lawrence Livermore National Laboratory
NETL — National Energy Technology Laboratory
NREL — National Renewable Energy Laboratory
ORNL — Oak Ridge National Laboratory
PNNL — Pacific Northwest National Laboratory
PPPL — Princeton Plasma Physics Laboratory
SLAC — Stanford Linear Accelerator Center
SNL — Sandia National Laboratories
SRTC — Savannah River Technology Center
TJNAF — Thomas Jefferson National Accelerator Facility

Department of Energy Terms and Facilities

ADAPT — Advanced Design and Production Technologies
AGEX — Above-Ground Experiments
AGS — Alternating Gradient Synchrotron
AHF — Advanced Hydrodynamics Facility
ALS — Advanced Light Source
AMES — Ames Laboratory (Not an acronym)
ANL — Argonne National Laboratory
APS — Advanced Photon Source
ARG — Accident Response Group
ARM — Atmospheric Radiation Measurements
ASCI — Accelerated Strategic Computing Initiative
ATF — Accelerator Test Facility
ATLAS — Argonne Tandem-Linac Accelerator System
ATR — Advanced Test Reactor
ATS — Advanced Turbine System
B&R — Budget and Reporting [Code]
BNL — Brookhaven National Laboratory
CEBAF — Continuous Electron Beam Accelerator Facility

CERN — The European Laboratory for Particle Physics
CIN — Center for Imaging and Neuroscience
CMS — Compact Muon Solenoid
CRADA — Cooperative Research and Development Agreement
CRF — Combustion Research Facility
CTBT — Comprehensive Test Ban Treaty
D&D — Decontamination and Deconditioning
D&D — Development and Demonstration
DARHT — Dual-Axis Radiographic Hydrodynamic Test
DNA — Deoxyribo Nucleic Acid
DNAPL — Dense Non-Aqueous Phase Liquid
DoD — Department of Defense
DOE — Department of Energy
DP — Office of Defense Programs, Department of Energy
DSW — Directed Stockpile Work
EERE — Office of Energy Efficiency and Renewable Energy, Department of Energy
EM — Office of Environmental Management, Department of Energy
EMSL — Environmental Molecular Sciences Laboratory
EPA — Environmental Protection Agency
ER — Office of Energy Research, now the Office of Science
FE — Office of Fossil Energy, Department of Energy
FEL — Free Electron Laser
FEMA — Federal Emergency Management Administration
FFRDC — Federally Funded Research and Development Center
FNAL — Fermi National Accelerator Laboratory
FSED — Full-Scale Engineering Development
FTE —Full Time Equivalent
GLAST — Gamma-ray Large Area Space Telescope
HAW — High Activity Waste
HEU — Highly Enriched Uranium
HiPPS — High Efficiency Performance Power System
HLW — High Level Waste
ICF — Inertial Confinement Fusion
IFEL — Infrared Free Electron Laser
INEEL or INEL — Idaho National Engineering and Environmental Laboratory
IRC —INEEL Research Center
JGI — Joint Genome Institute
LANL — Los Alamos National Laboratory
LBNL — Lawrence Berkeley National Laboratory
LEAF — Laser Electron Accelerator Falcility
LEBS — Low Emissions Boiler System
LEU — Low Enriched Uranium
LIGA — Lithography, electroplating, and molding (a micro-machining technology; the acronym is based on the German name)
LLNL — Lawrence Livermore National Laboratory
LOB — Laboratory Operations Board
MEMS — Micro-Electro Mechanical Systems

MESA — Microsystems and Engineering Sciences Applications
MGR — Mined Geological Repository
MINOS — Main Injector Neutrino Oscillation Search
MLLW/TRU — Mixed Low-Level/Transuranic Waste
MOX — Mixed Oxide
MPC — Materials Preparation Center
MPC&A — Materials Protection, Control and Accounting
MRI — Magnetic Resonance Imaging
MRSH — Materials Referral System Hotline
MUCAT — Midwest University Collaborative Access Team
NABIR — Natural and Accelerated Bioremediation Research
NASA — National Aeronautics and Space Administration
NCAR — National Center for Atmospheric Research
NEPO — Nuclear Energy Plant Optimization
NERSC — National Energy Research Scientific Computing Center
NEST — Nuclear Emergency Search Team
NETL — National Energy Technology Laboratory
NFE — Non Federal Entities
NIF — National Ignition Facility
NIH — National Institute of Health
NN — Office of Nuclear Non-proliferation, Department of Energy
NNSA — National Nuclear Security Administration
NRC — Nuclear Regulatory Commission
NREL — National Renewable Energy Laboratory
NSF — National Science Foundation
NSLS — National Synchrotron Light Source
NSTX — National Spherical Torus Experiment
OFA — Other Federal Agencies
ORNL — Oak Ridge National Laboratory
PEP — Positron Electron Project
PET — Positron Emission Tomography
PETL — Processing and Environmental Technology Laboratory
PNNL — Pacific Northwest National Laboratory
PPPL — Princeton Plasma Physics Laboratory
PSO — Program Secretarial Office
R&D — Research and Development
RD&D — Research, Development, and Demonstration
RHIC — Relativistic Heavy Ion Collider
RIC — Rare-earth Information Center
RSM — Radioactive Scrap Metal
RTBF — Readiness in Technical Base and Facilities
SC — Office of Science, Department of Energy
SEAB — Secretary of Energy Advisory Board
SLAC — Stanford Linear Accelerator Center
SLC — Stanford Linear Collider
SLEP — Stockpile Life Extension Program
SNF — Spent Nuclear Fuel

SNL — Sandia National Laboratories
SNM — Special Nuclear Material
SNS — Spallation Neutron Source
SPEAR — Stanford Positron Electron Accelerating Ring
SRS — Savannah River Site
SRTC — Savannah River Technology Center
SSP — Stockpile Stewardship Program
SST — Safe Secure Transport
TFTR — Tokamak Fusion Test Reactor
TJNAF — Thomas Jefferson National Accelerator Facility
TRU — Transuranic
TVS — Transportable Vitrification System
WFA — Work for Others
WMD — Weapons of mass destruction